EXHIBIT B

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent of:	Wang et al.		
U.S. Patent No.:	8,429,480	Attorney Docket No.:	35548-0130IP1
Issue Date:	April 23, 2013		
Appl. Serial No.:	12/681,687		
§371(c)(1), (2), (4) Date:	June 24, 2010		
Title:	USER SPECIFIC LOAD BALANCING		

DECLARATION OF MR. PETER RYSAVY

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I, Peter Rysavy, declare as follows:

I. ASSIGNMENT

1. I have been retained as a technical expert by counsel on behalf of Huawei Technologies Co., Ltd. ("Huawei"). I understand that Huawei is requesting that the Patent Trial and Appeal Board institute an *inter partes* review ("IPR") proceeding with respect to U.S. Patent No. 8,429,480. (the '480 patent) (Ex-1001).

2. I have been asked to provide my independent analysis of the '480 patent in light of the prior art publications cited in Section V below.

3. I am not, and never have been, an employee of Huawei. I received no compensation for this declaration beyond my normal hourly compensation based on my time actually spent analyzing the '480 patent, the prior art publications cited in Section V below, and issues related thereto, and I will not receive any added compensation based on the outcome of any IPR or other proceeding involving the '480 patent.

II. QUALIFICATIONS

4. I graduated with BSEE and MSEE degrees from Stanford University in 1979, with my master's degree emphasizing communications technologies.

5. From 1988 to 1993, I was vice president of engineering and technology at Traveling Software (later renamed LapLink), at which projects

included LapLink, LapLink Wireless, and connectivity solutions for a wide variety of computing platforms. During this period, I was responsible for evaluating wireless communications technologies for use with the LapLink file transfer and synchronization product families. I also managed the development of a short-range wireless modem called LapLink Wireless that replaced a serial-data cable connection between computers. Prior to Traveling Software, I spent seven years at Fluke Corporation, where I worked on data-acquisition products and touch-screen technology.

6. I am now the president of the consulting firm Rysavy Research LLC and have worked as a consultant in the field of networking systems and wireless technology since 1993. As a consultant I specialize in wireless systems, including the wireline networking systems that support them. My work includes working with networking protocols at all layers of the protocol stack, including the TCP/IP family of protocols. One of my clients in 1994 was McCaw Cellular (which later became AT&T Wireless), the leading U.S. cellular company at the time. I did multiple projects for McCaw Cellular, helping me develop my expertise in networking technologies.

7. Beginning in 1994, I began teaching public courses, including courses that I taught at Portland State University, the University of California at Los Angeles, at conferences, and through my own organization. These courses included

content about cellular networks, Wi-Fi and other wireless local area networks, Bluetooth, paging, and mobile-application architectures.

8. Past projects have included reports on the evolution of wireless networking technologies, evaluation of wireless technologies, strategic consultations, system design, articles, courses and webcasts, network performance measurement, test reports, and involvement in multiple patent litigation cases. My past and current clients include more than one hundred organizations.

9. I have written more than one hundred and eighty articles, reports, and papers, and have taught more than forty public courses and webcasts, on networking technologies. I have also performed technical evaluations of many wireless networking technologies, including mobile browsers, wireless e-mail systems, municipal/mesh Wi-Fi networks, Wi-Fi hotspot networks, cellular-data services, and social networking applications.

10. From 2000 to 2016, as part of my consulting practice, I was the executive director of the Portable Computer and Communications Association (PCCA), which was formally incorporated in May of 1993, then operated as the Wireless Technology Association. The PCCA's mission was to promote the interoperability of wireless-data systems, and its initial work was to develop interfaces between computers and wireless modems.

11. In the more than twenty-five years of my consulting career, I have studied or worked with nearly every major wireless technology related to cellular networks and wireless local-area networks. Further detail on my background and work experience, along with a list of my publications and the cases in which I have given testimony, is contained in my CV.

III. LEGAL PRINCIPLES

12. In forming my analysis and conclusions expressed in this declaration, I have applied the legal principles described in the following paragraphs, which were provided to me by counsel for the Petitioner.

A. Obviousness

13. I have been informed that a patent claim is invalid as "obvious" in light of one or more prior art references if it would have been obvious to a person of ordinary skill in the art at the time of the alleged invention ("POSITA"), taking into account (1) the scope and content of the prior art, (2) the differences between the prior art and the claims, (3) the level of ordinary skill in the art, and (4) any so called "secondary considerations" of non-obviousness, which include: (i) "long felt need" for the claimed invention, (ii) commercial success attributable to the claimed invention, (iii) unexpected results of the claimed invention, and (iv) "copying" of the claimed invention by others.

14. While I do not know the exact date that the alleged invention claimed in the '480 patent was made, I do know that the '480 patent claims priority to a

provisional patent application filed on October 5, 2007. For purposes of my obviousness analysis, I have applied a date of October 5, 2007, as the date of the alleged invention, although in many cases the same analysis would hold true even if the date of the alleged invention were earlier.

15. I have been informed that a claim can be obvious in light of a single prior art reference or multiple prior art references. To be obvious in light of a single prior art reference or multiple prior art references, there must be a reason that would have prompted a POSITA to modify or supplement the single prior art reference, or to combine two or more references, in a manner that provides the elements of the claimed invention. This reason may come from a teaching, suggestion, or motivation to combine, or may come from the reference(s) themselves, the knowledge or "common sense" of a POSITA, or from the nature of the problem to be solved, and this reason may be explicit or implicit from the prior art as a whole. I have been informed that, under the law, the combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results. I also understand it is improper to rely on hindsight in making the obviousness determination.

B. Claim Construction

16. I understand that, for purposes of my analysis in this *inter partes* review proceeding, the terms appearing in the patent claims should be interpreted

according to their "ordinary and customary meaning," which is often referred to as the *Phillips* standard. In determining the ordinary and customary meaning, I understand that the words of a claim are first given their plain meaning that those words would have had to a person of ordinary skill in the art at the time of the alleged invention. I also understand that the structure of the claims, the specification and file history also may be used to better construe a claim insofar as the plain meaning of the claims cannot be understood. Moreover, I understand that even treatises and dictionaries may be used, albeit under limited circumstances, to determine the meaning attributed by a person of ordinary skill in the art to a claim term at the time of filing. Unless otherwise noted, I have applied the plain and ordinary meaning of the '480 patent's claim terms throughout my analysis.

17. I also understand that the words of the claims should be interpreted through the lens of a POSITA at the time the alleged invention was made (not today). Because I do not know at what date the alleged invention was made, I have used the filing date of the provisional application to which the '480 patent claims priority (October 5, 2007).

IV. PERSON OF ORDINARY SKILL IN THE ART

18. Based on my knowledge and experience in the field and my review of the '480patent and its file history, I believe that would have had at least a Master's degree in computer science, computer engineering, electrical engineering, or a

related field, with 3-5 years of experience in the field of wireless communication systems. *See* Ex-1001, 1:13-16 ("relate[s] generally to wireless communication systems[] …"). Such experience could be obtained through research and study in a graduate program or through comparable exposure to research literature through industry employment working in the field of data communications networks, and additional years of experience could substitute for the advanced-level degree. My analysis and conclusions as expressed herein are thus based on the perspective of a person of ordinary skill in the art having this level of knowledge and skill at the time of the alleged invention of the '480 patent.

V. MATERIALS CONSIDERED

19. The analysis and conclusions set forth in this declaration are informed by my educational background and experiences in the field (*see* Section II). Based on my above-described experience, I believe that I am considered to be an expert in the field. Also, as detailed above, I understand and know of the capabilities of a POSITA as of October 5, 2007, and I taught, participated in organizations, and worked closely with many such persons whom I would consider to qualify as a POSITA in the field during that time frame.

20. In general, as part of my independent analysis for this declaration, I have considered the following: the background knowledge/technologies that were commonly known to a POSITA before the earliest claimed priority date for

the ’480 patent; my own knowledge and experiences gained from my work experience in the field and related disciplines; and my experience in working with others involved in this field and related disciplines. In addition, I have analyzed the following publications and materials:

- Ex-1001 U.S. Pat. No. 8,429,480 to Wang et al. (“the ’480 patent”)
- Ex-1002 File History of the ’480 Patent
- Ex-1005 China Academy of Telecommunications Technology (CATT), R2-074183, “Semi-Persistent Scheduling for UL VoIP in TDD,” For Discussion and Decision at 3GPP TSG-RAN WG2 Meeting #59bis in Shanghai, China (October 8-12, 2007) (“CATT183”)
- Ex-1006 Nokia, R2-070476, “Uplink Scheduling for VoIP,” For Discussion and Decision at 3GPP TSG-RAN WG2 Meeting #57 in St. Louis, Missouri (February 12-16, 2007) (“Nokia476”)
- Ex-1007 China Academy of Telecommunications Technology (CATT) and RITT, R2-070115, “Collision resolution While Using Synchronous HARQ,” For Discussion at 3GPP TSG-RAN WG2 Meeting #56bis in Sorrento, Italy (November 15-19, 2007) (“CATT115”)
- Ex-1008 U.S. Patent Application Publication No. 2006/0256757 (“Kuusela”)
- Ex-1009 3GPP TS 36.300 v8.1.0, Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access Network (E-UTRAN); Overall Description Stage 2 (Release 8) (“TS_36_300”)

- Ex-1010 U.S. Patent Application Publication No. 2007/0177630 (“Ranta”)

- Ex-1011 *WSOU Investments, LLC v. Huawei Investment & Holding Co., Ltd.*, Case No. 6:20-cv-544, Original Complaint For Patent Infringement (W.D. Tex. June 17, 2020)

- Ex-1012 LTE Overview, 3GPP, *available at* https://www.3gpp.org/technologies/keywords-acronyms/98-lte (accessed Nov. 7, 2020)

- Ex-1013 3GPP TS 36.321 v1.0.0, Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification (Release 8) (“TS_36_321”)

- Ex-1014 UTRA-UTRAN Long Term Evolution (LTE) and 3GPP System Architecture Evolution (SAE), *Long Term Evolution of the 3GPP Radio Technology, available at* ftp://ftp.3gpp.org/Inbox/2008_web_files/LTA_Paper.pdf (accessed Nov. 8, 2020)

- Ex-1015 Puttonen et al., *Voice-over-IP Performance in UTRA Long Term Evolution Downlink* (May 2008)

- Ex-1016 3GPP TS 36.211 v8.0.0, Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation (Release 8) (“TS_36_211”)

21. Although this declaration refers to certain portions of the cited references for the sake of brevity, it should be understood that these citations are examples, and that one of ordinary skill in the art would have viewed the references cited herein in their entireties and, for reasons detailed later, in combination with other references cited herein or cited within those references

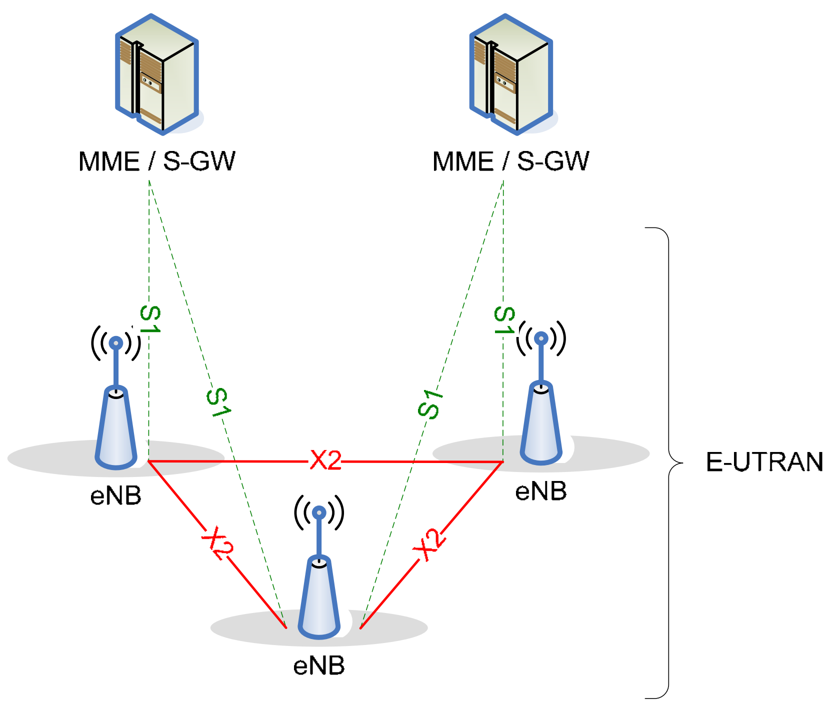
themselves. The references used in this declaration, therefore, should be viewed as being cited and analyzed herein in their entireties.

VI. BACKGROUND OF THE ’480 PATENT

A. Technical Overview

22. The ’480 patent relates to wireless communication systems, and particularly describes techniques in the context of an “evolved UTRAN” system. Ex-1001, 1:13-19, 1:58-63. Evolved UTRAN (Universal Terrestrial Radio Access Network)—commonly branded as 4G Long Term Evolution (or simply “LTE”)—refers to a wireless standard that was in active development by members of the “3GPP” standards body at the time of the ’408 patent’s earliest possible priority date (October 5, 2007). Ex-1012. LTE was intended to provide a wireless access network designed for “high spectral efficiency, high peak data rates, short round trip time as well as flexibility in frequency and bandwidth.” *Id*. LTE was also optimized to support wireless access to the Evolved Packet System (EPS), which was a “purely IP based” core offering packet-switched voice services in lieu of circuit-switched services that were the norm in prior wireless systems such as GSM. *Id*., 1. Formal work on the LTE standard commenced in 2004, and continued for years thereafter (including during the October 2007 timeframe of the ’408 patent’s earliest possible priority date) to complete Release 8. Ex-1014, 1. “Release 8 was frozen in December 2008 and [] has been the basis for the first wave of LTE equipment.” Ex-1012, 1.

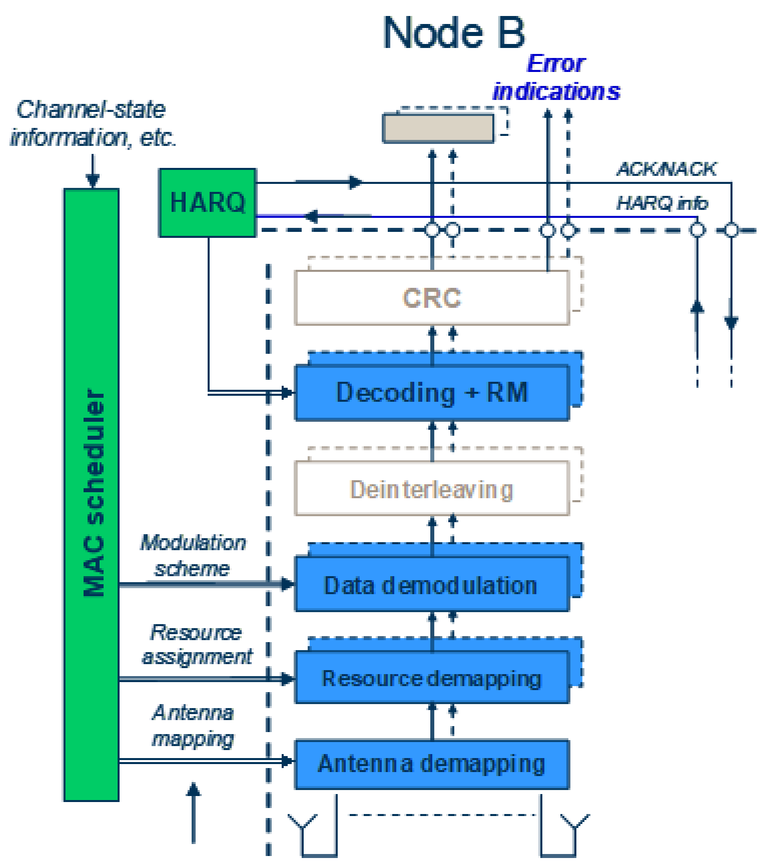
23. E-UTRAN systems include base stations (referred to as the "e-NodeB" or "eNB") and wireless devices (referred to as "User Equipment" or "UE") such as smartphones that communicate over-the-air to deliver services to end users. Ex-1009, 12-13. The eNBs interface on the back-end with the core network, and also manage connections with UEs. *Id.* For example, the eNB implements functions for "Radio Resource Management," "Radio Bearer Control," and "Dynamic allocation of resources to UEs in both uplink and downlink (scheduling)." *Id.*, 13.



Ex-1009, FIG. 4 (p. 13).

24. Since "E-UTRAN is optimized for packet data transfer and the core network is purely packet switched, [] speech is transmitted purely with Voice-over IP (VoIP)." Ex-1015, 2. VoIP (speech) packets are typically transmitted from the

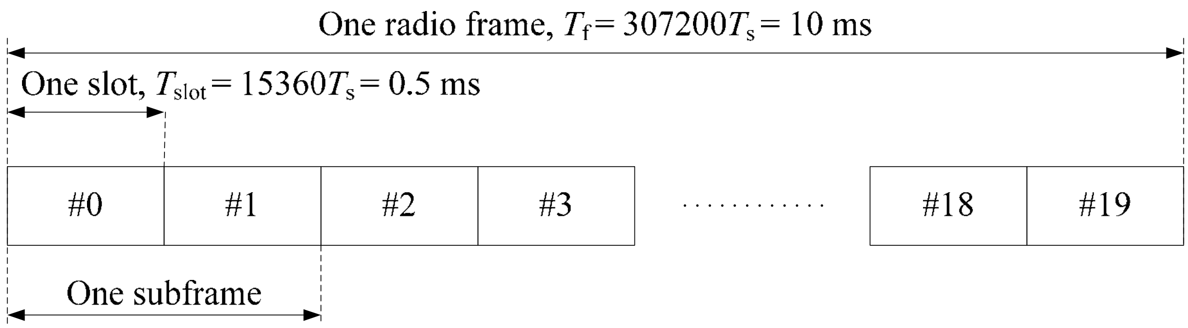
UE to the eNB at ~20 ms intervals. *Id*. However, since eNBs ordinarily support communications with many UEs concurrently (and the UEs may be located in close proximity to each other), transmissions among UEs must be coordinated to avoid interference and ensure reliable data delivery from the UE to the eNB. In LTE, the eNB is responsible for coordinating uplink transmissions with a functional unit referred to as the "MAC [medium access control] scheduler." Ex-1009, 29.



Ex-1009, FIG. 5.4.1.5 (p. 29) (cropped).

25. In particular, the MAC scheduler schedules and allocates uplink "resources" to UEs, which are then used to carry uplink data to the eNB. *Id.* An allocated resource generally corresponds to a time-frequency block on which the UE is granted permission to transmit data to the eNB. Ex-1009, 56 ("Resource assignment consists of physical resource blocks (PRB) and [modulation and coding scheme] (MCS). … In the uplink, E-UTRAN can dynamically allocate resources (PRBs and MCS) to UEs at each [time transmission interval (TTI)] …"). Through orderly allocation of uplink resources, the MAC scheduler ensures that UEs can communicate with the eNB without interference from other UEs in the same time-frequency blocks.

26. Transmissions and resource allocation in LTE occur in the context of "frames," which are constructs that organize radio resources in 10 ms intervals. EX1016, 8 ("Downlink and uplink transmissions are organized into radio frames with T_f … = 10 ms duration."). The 10 ms frame consists of 10 subframes of 1 ms duration each, and each subframe consists of 2 slots of 0.5 ms duration each. EX1016, 8. The following diagram illustrates one type of frame structure defined in LTE:



EX1016, FIG. 4.1-1 (p. 8).

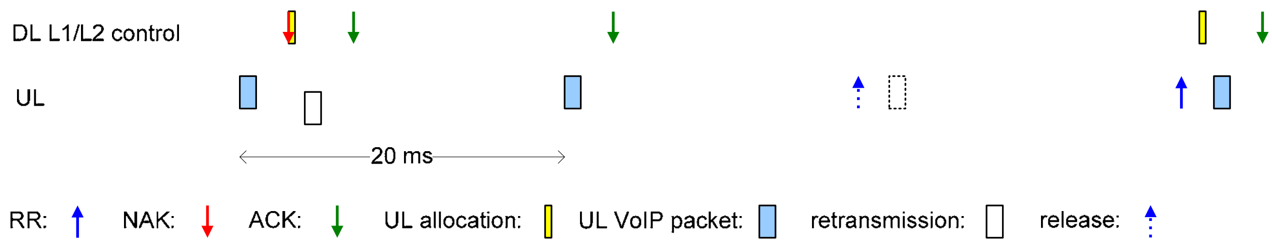
27. LTE can operate in frequency division duplex (FDD) mode, with separate radio channels for the downlink and uplink. Alternatively, using time division duplex (TDD) mode, the same radio channel supports both downlink and uplink with either downlink or uplink operational at any moment in time. For TDD operation, the '480 patent's background discussion identifies several possible uplink-downlink configurations such as "DSUUD," "DSUDD," "DSUUUDDDDD," and "DSUUDDDDDD." Ex-1001, 2:39-40, FIG. 1. These configurations define sequences of assignments for sub-frames in TDD to either downlink transmissions (D), uplink transmissions (U), or special operation (S). The 10-character sequences specify the sub-frame configuration across the full 10 ms frame, while the 5-character sequences specify the sub-frame configuration across a 5-ms half frame that repeats identically across sub-frames 0-4 and 5-9 of the 10-ms frame, as shown in the following figure:

DSUUD	D	S	U	U	D	D	S	U	U	D
DSUDD	D	S	U	D	D	D	S	U	D	D
DSUUUDDDDD	D	S	U	U	U	D	D	D	D	D
DSUUDDDDDD	D	S	U	U	D	D	D	D	D	D
Sub-Frame #	0	1	2	3	4	5	6	7	8	9

28. As noted above, the MAC scheduler at the eNB allocates resources for UEs to transmit VoIP packets, and the allocated resources allow the UE to transmit during one or more uplink sub-frames. During a voice session, the UE can transmit VoIP packets every 20 ms if appropriate uplink resources have been allocated for the transmissions. In this regard, the '480 patent cites Nokia476 (Ex-1006), which describes several scheduling schemes for uplink VoIP in LTE. Ex-1001, 2:33-37. These options included "fully dynamic scheduling," "fully persistent scheduling," and "semi-persistent scheduling." Ex-1006, 1-3. In fully dynamic scheduling, "the UE sends a resource request in UL for every VoIP packet" and the eNB "allocates [an] UL resource for every VoIP packet separately …" Ex-1006, 1. While fully dynamic scheduling provides the most scheduling freedom, it also requires a significant amount of signaling overhead to request and allocate a resource for each VoIP packet separately. *Id.*, 1-2. By contrast, in fully persistent scheduling, uplink resources are persistently allocated to permit transmission of VoIP packets on a regular basis (e.g., every 20 ms)—i.e.,

without need for separate scheduling of each packet. Ex-1006, 2. This approach significantly reduces the amount of signaling overhead necessary for uplink VoIP, but can also result in inefficient use of uplink resources. Ex-1006, 2-3. For instance, a persistent resource may be pre-allocated to a UE even when no voice packets are available for transmission (e.g., during voice silent periods). Ex-1006, 2-3. Indeed, Nokia476 recognized that "VoIP users are on average half of the time silent," and "a significant amount of VoIP capacity is wasted if the silence periods are not reallocated to other VoIP users." *Id.*, 3.

29. To realize the benefits associated with both fully dynamic and fully persistent scheduling (while mitigating their drawbacks), Nokia476 proposed a middle ground, referred to as "semi-persistent scheduling." Ex-1006, 3-4. In this scheme, "persistent allocation is done separately for each talk spurt." *Id.*, 3. "When a talk spurt starts, the UE should send a resource request, then the radio resource is allocated to the UE and when the talk spurt ends, the resource is released (explicitly with release signaling or implicitly by noticing that no more data is coming." *Id.* By releasing resources during silent periods, these resources can be "reallocated to other VoIP users." *Id.* Figure 3 of Nokia476 illustrates the concept of semi-persistent allocation of UL VoIP:



Ex-1006, FIG. 3 (p. 3).

30. Due to noise and other factors, not all VoIP packets transmitted from a UE will be properly received by an eNB. LTE provides several features to address this problem and increase the probability that packets will be successfully delivered to the eNB. *Id.* One such feature that is the focus of the '480 patent is "HARQ"—i.e., Hybrid Automatic Repeat Request. Ex-1001, Abstract, 2:4-62. In general, HARQ processes combines principles of standard ARQ (automatic repeat request) and FEC (forward error correction) processes. Standard ARQ processes provide error control through acknowledgment messages. When a transmitting device sends a packet (or other unit of data, including a frame) to a receiver, the transmitting device waits for the receiver to return an acknowledgment message confirming receipt of the packet before the transmitter attempts to send the next packet. *Id.* FEC relates to methods for encoding data before transmission such that a receiver can detect and self-correct a limited number of errors in the received packet without requiring retransmission. *Id.* HARQ draws from both ARQ and FEC by encoding data packets transmitted between the UE and eNB with error-correction codes such that the receiving device can correct some errors in received

packets without necessarily needing to retransmit the packet. At the same time, HARQ also provides for the receiver to return acknowledgments (e.g., ACKs/NACKs) to the transmitting device indicating whether a packet was successfully received/decoded or whether retransmission is required. *Id.*

31. The ’480 patent explains that LTE UEs implement “N parallel hybrid ARQ processes,” and the HARQ processes are “synchronous.” HARQ generally relates to the sequence of transmissions and re-transmissions employed successfully deliver packets. Ex-1001, 2:6-26. In this context, “re-transmission must take place within the same HARQ process as its initial/new/first transmission.” *Id.*, 2:21-26. However, the ’480 patent identifies a problem that can arise in the context of semi-persistent scheduling and synchronous HARQ, namely that a retransmission of a first packet (according to semi-persistent scheduling) and initial transmission of a second packet (according to synchronous HARQ) would conflict when each is scheduled to occur at the same time from the same UE. *See* Ex-1001, 6:30-43, FIG. 3.

B. Overview Of Proposed Techniques

32. Based on the observation that collisions would theoretically occur between re-transmissions of a first packet and new transmissions of a second packet in a HARQ process, the ’480 patent disclosed techniques for “performing UE [] specific load balancing among HARQ processes, in particular for the case of

semi-persistent scheduling the LTE TDD UL." Ex-1001, 6:30-35. "More specifically, when a new transmission packet and re-transmission packet from one UE [] occur within one HARQ process, the re-transmission packet is transmitted during the time at which a collision would occur, and the new transmission packet is dynamically scheduled to a new resource in another, different HARQ process." *Id.*, 6:38-43. Figure 3 shows one example these techniques:

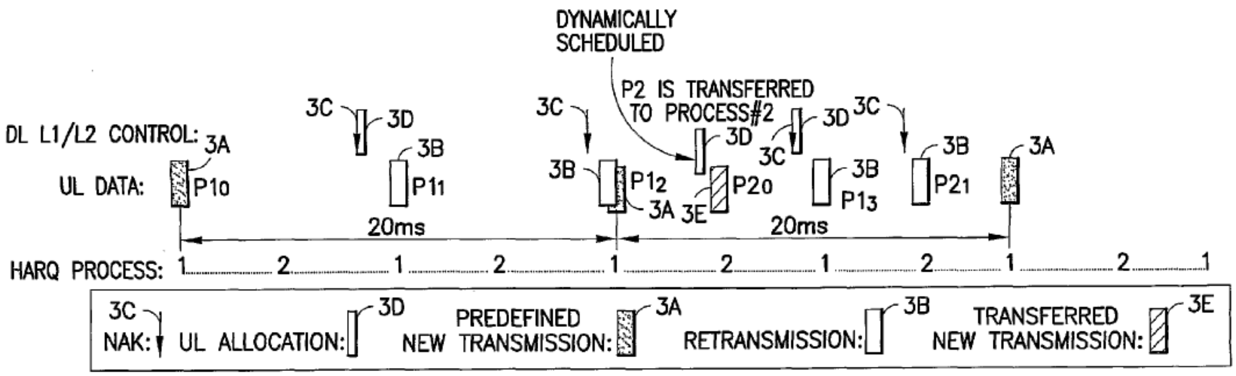


FIG.3

Ex-1001, FIG. 3.

33. As depicted in Figure 3, a conflict arises in the third frame between the retransmission of packet P1, shown as $P1_2$ and the semi-persistently scheduled transmission of new packet P2. *Id.*, 6:44-7:20, FIG. 3. The '480 patent proposes to resolve the conflict by maintaining the retransmission of packet P1 in the originally allocated resource using HARQ process #1, but diverting the initial transmission of packet P2 to a different HARQ process #2 in a different subframe. *Id.* Since uplink resources were not previously allocated for a different subframe for HARQ process #2, the eNB (e.g., the MAC scheduler) dynamically allocates

such resources (shown as $P2_0$, $P2_1$), thereby enabling the UE to transmit packet P2 in this process separately from P1. *Id.*

C. Summary Of File History

34. I understand that the '480 patent was filed in the United States on April 5, 2010, and claims priority to a provisional application filed October 5, 2007. *Generally* Ex-1002, 97-151. The Examiner mailed one Office Action during the course of prosecution of the '480 patent, which rejected certain claims as allegedly indefinite. Ex-1002, 30-34. However, the Examiner made no prior art rejections in this Office Action. After the applicant responded to the Office Action addressing the indefiniteness rejection, the Examiner mailed a Notice of Allowance. Ex-1002, 9-13. Based on my review, the Examiner did not expressly identify specific reasons for allowance. *Id.*

VII. OVERVIEW OF CONCLUSIONS FORMED

35. This declaration explains the conclusions that I have formed based on my independent analysis. To summarize those conclusions:

- Claims 11-13 would have been obvious based on teachings from the prior art combination of CATT183 AND Nokia476.
- Claims 14-16 would have been obvious based on teachings from the prior art combination of CATT183, Nokia476, and Ranta.

- Claims 17-20 would have been obvious based on teachings from the prior art combination of CATT183, Nokia476, and TS_36_300.
- Claims 1, 3-4, and 7-10 would have been obvious based on teachings from the prior art combination of CATT183, Nokia476, TS_36_300, and CATT115.
- Claims 5 and 6 would have been obvious based on teachings from the prior art combination of CATT183, Nokia476, TS_36_300, CATT115, and Ranta.
- Claims 1, 4, and 7-9 would have been obvious based on teachings from the prior art combination of CATT115, Kuusela, and TS_36_300.
- Claims 3 and 10 would have been obvious based on teachings from the prior art combination of CATT115, Kuusela, TS_36_300, and Nokia476.
- Claims 5 and 6 would have been obvious based on teachings from the prior art combination of CATT115, Kuusela, TS_36_300, and Ranta.
- Claims 11, 13-14, and 16 would have been obvious based on teachings from the prior art combination of CATT115, Kuusela, and Nokia476.

- Claims 12, 15, and 17-20 would have been obvious based on teachings from the prior art combination of CATT115, Kuusela, Nokia476, and TS_36_300.

VIII. OVERVIEW OF PRIOR ART REFERENCES

A. CATT183

36. CATT183 is a published submission to a 3GPP working group meeting in October 2007. EX1005, 1. CATT183 describes the problem of conflicts arising between re-transmissions in synchronous HARQ and initial transmissions in semi-persistently scheduled initial packet transmissions:

> [S]emi-persistent scheduling has been adopted for VoIP. In the uplink, E-UTRAN allocates predefined resources for the first HARQ transmissions and potentially retransmissions to UEs, and HARQ is based on synchronous retransmissions. Because of distinct feature in frame structure compared with FDD, a possible HARQ RTT value is 10ms in TDD. Accordingly, for voice packet which persistent resource interval equal to 20ms, the initial transmission of the current voice packet will be conflicted with the 2nd retransmission of the last voice packet. This contribution will propose some feasible schemes to resolve the conflict.

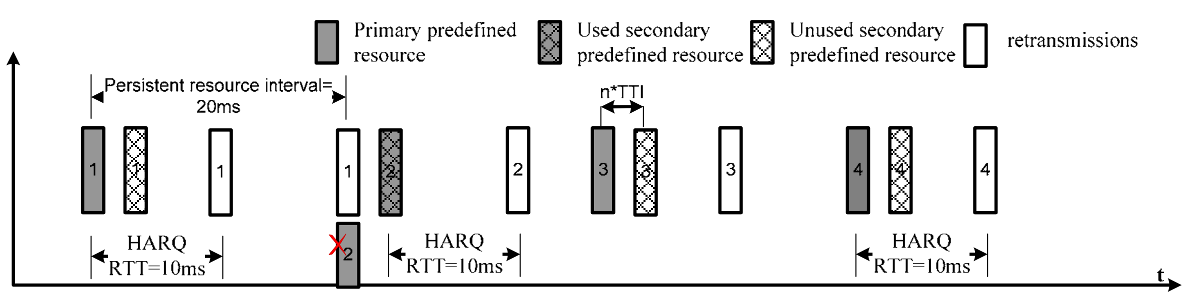
Ex-1005, 1.

37. CATT183 further discusses a solution to this problem that involves diverting the initial transmission of a new packet to a different HARQ process if there is a conflict with a retransmission in a first HARQ process. Ex-1005, 2-3 ("Alt 2"). CATT 183 described this technique as follows:

> Allocate two persistent resources to voice packet in adjacent uplink subframes, named "primary predefined resource" and "secondary predefined resource". The interval between them is n*TTI, where n≥1 and n will be small so that the packet can be transmitted quickly. If there is the 2nd retransmission of the last voice packet use the primary predefined resource, then the initial transmission of the current voice packet will use the secondary predefined resource. Otherwise, the initial transmission will use the primary predefined resource, and the secondary predefined resource can be dynamically scheduled to other service.

Ex-1005, 3.

38. Figure 3 of CATT183 illustrates the proposed "Alt 2" solution:

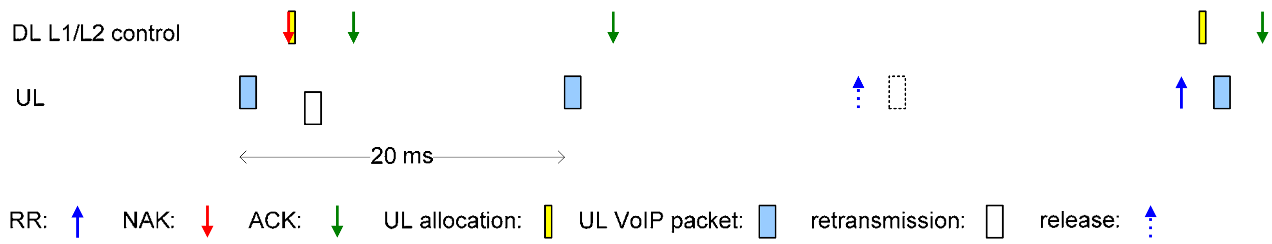


Ex-1005, FIG. 3 (p. 3).

B. Nokia476

39. Nokia476 is a published submission to a 3GPP working group meeting in February 2007. EX1006, 1. Nokia476 describes several scheduling alternatives for uplink VoIP in LTE systems. Ex-1006, 1; *generally id.*, 1-5. The disclosed alternatives include fully dynamic scheduling, fully persistent scheduling, and semi-persistent scheduling. *Id.*; *supra*, Section V.A (providing overview of each scheme).

40. The '480 patent's background discussion acknowledges that "[s]emi-persistent scheduling has [] been agreed to for use in LTE, wherein initial/new transmissions of voice packets are persistently allocated (a set of resources in every 20 ms are predefined) and re-transmissions of packets are dynamically scheduled by Layer 1/Layer 2 signaling." Ex-1001, 2:27-32. Nokia476 provides additional detail regarding semi-persistent scheduling, and further discloses ordinary signaling exchanges that occur between a UE and eNB in an E-UTRAN (LTE) system to acknowledge successful/unsuccessful receipt of uplink transmissions and to dynamically allocate or schedule resources to the UE for upcoming transmissions. Ex-1006, 1-5. Figure 3, for example, depicts an example signaling exchange in the context of semi-persistent scheduling:



Ex-1006, FIG. 3 (p. 3).

C. Ranta

41. Ranta is a U.S. published patent application that discloses "wireless communications systems and, more specifically, … techniques that provide for a retransmission of data." Ex-1010, [0002]. Ranta's techniques are applicable to wireless systems including LTE and E-UTRAN. Ex-1010, [0047] ("By way of introduction, in current standardization efforts, such as those for a proposed 3GPP UTRA and UTRAN long term evolution (LTE) network, it may be useful to employ HARQ."), [0104]-[0107].

42. Ranta further describes components of wireless systems such as LTE. Ex-1010, [0052]-[0055], FIG. 1; *see also id.*, [0121]-[0125]. For instance, Figure 1 depicts "a wireless network 1 [] adapted for communication with a UE 10 via a base station (e.g., Node B or BTS) 12." *Id.*, [0052].

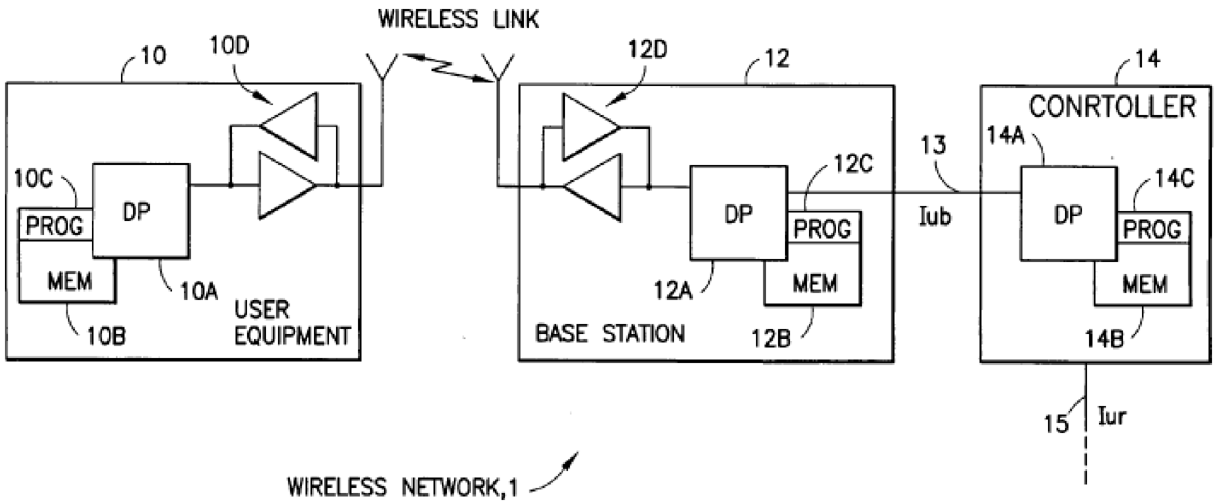
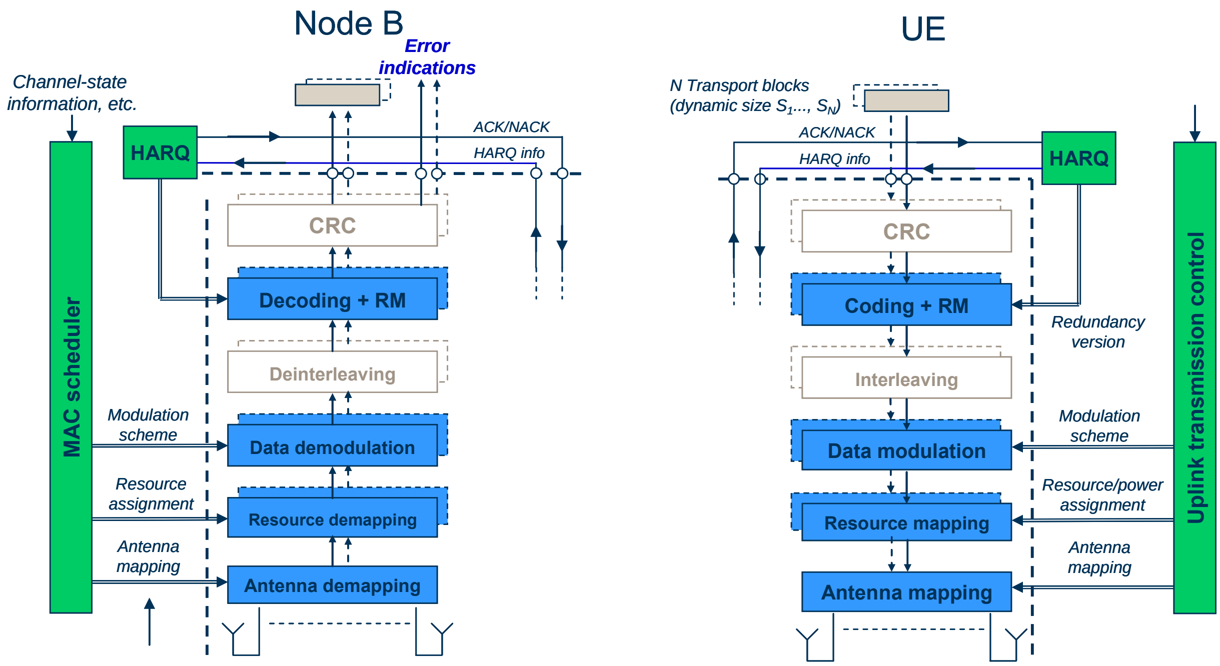


FIG.1

Ex-1010, FIG. 1.

D. TS_36_300

43. TS_36_300 is a 3GPP technical specification that "provides an overview and overall description of the E-UTRAN radio interface protocol architecture." Ex-1009, 1. TS_36_300 describes elements of the UE and eNodeB in E-UTRAN, and provides a physical layer model in Figure 5.4.1.5:



Ex-1009, FIG. 5.4.1.5 (p. 29).

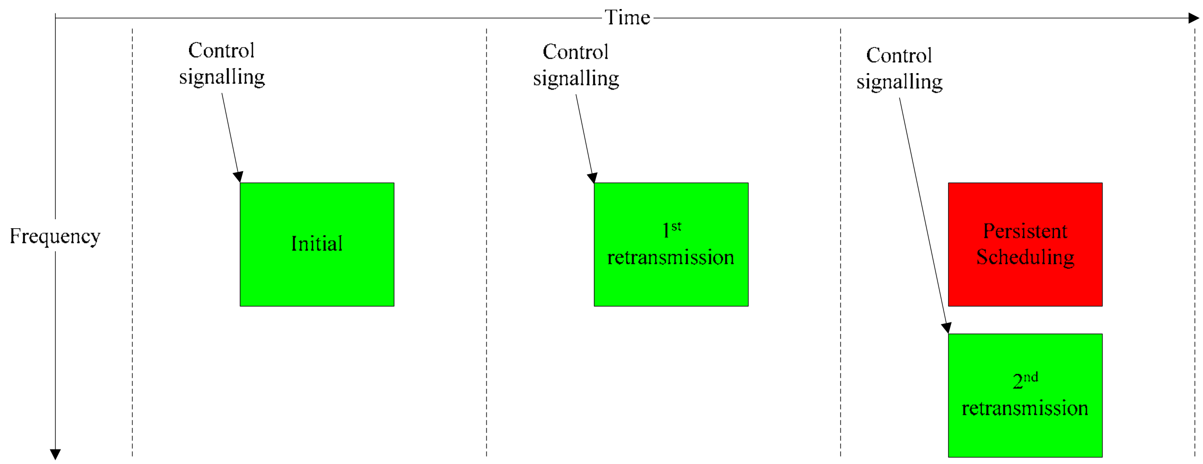
44. TS_36_300 explains that the medium access controller (MAC) in eNB "includes dynamic resource schedulers that allocate physical layer resources for the DL-SCH and UL-SCH transport channels." Ex-1009, 56. Regarding uplink scheduling, TS_36_300 discloses that "E-UTRAN can dynamically allocate resources (PRBs and MCS) to UEs at each TTI via the C-RNTI on L1/L2 control channel(s)." *Id.*, 56. Additionally, "E-UTRAN can allocate a predefined uplink resource for the first HARQ transmissions and potentially retransmissions to UEs." *Id.* For example, as shown in Figure 5.4.1.5, the eNB includes a HARQ functional unit associated with the MAC scheduler to facilitate performance of HARQ-related functions. *Id.*, §11.

E. CATT115

45. CATT115 is a published submission to a 3GPP working group meeting titled "Collision Avoidance While Using Synchronous HARQ." EX1007, 1. CATT115 describes the problem of collisions that occur "when using synchronous HARQ" in the E-UTRA uplink. Ex-1007, 1. "Compared with asynchronous HARQ, synchronous HARQ implies that (re)transmissions for a certain HARQ process are restricted to occur at known time instants." Ex-1007, 1. "This feature leads to collisions while other mechanisms are adopted at the same time, such as persistent scheduling." *Id.*

46. To this end, CATT115 proposed solutions for "collision resolution." *Id.*, 1. Among these solutions, CATT115 describes an option for dynamically allocating resources for retransmission of a first packet, while using predefined resources (from persistent scheduling) for initial transmission of a second packet. *Id.*, 1-2.

> With adaptive synchronous HARQ, it seems that the collisions incurred due to synchronous operation can easily avoid by changing the resource unit assignment of special retransmission that will conflict with other transmission. Fig 1 shows an example.



> In Fig 1, after the 1st retransmission fails, the MAC scheduler becomes aware of that the 2nd retransmission will conflict with persistent scheduling. So the scheduler notices the UE that the 2nd retransmission will continue in different resource units from previous retransmission by corresponding control signalling.

Ex-1007, 1-2.

F. Kuusela

47. Kuusela is a U.S. published patent application that describes techniques for "improve[ing] capacity in the context of, for example, VoIP on [High Speed Uplink Packet Access (HSUPA)] or any other discontinuous data transmission." Ex-1008, [0015]; *generally id.*, [0015]-[0026], Abstract.

48. Like CATT183 and CATT115, Kuusela similarly highlights the problem of collisions that can occur between retransmissions in a HARQ process and initial transmissions of VoIP packets. For instance, Kuusela explains that "[i]n

case of 10 ms TTI, a simple principle with VoIP service using a packet every 20 ms would be, for example, to allow transmission of only every second ARQ process (odd or even)." Ex-1008, [0023]. "Further optimization could include taking into account an additional process for when retransmission is needed and there would be a conflict between the retransmission and the next packet arriving …, and more processed could be used only when retransmission is needed then." *Id.*

49. Kuusela discloses two predictable alternatives for resolving a conflict between a "retransmission" and an initial transmission for the next VoIP packet: (1) "the retransmission could be delayed by one 10 ms frame taking the place of a normally unused process," or (2) "[a]lternatively, the new transmissions could be delayed by one 10 ms frame, taking the place of [a] normally unused process and without delaying the retransmission." *Id.*, [0024]-[0025]; *see also id.*, [0016].

IX. ANALYSIS OF COMBINATION BASED ON CATT183 AND NOKIA476

A. First Predictable Combination Overview

50. As I described above in §VIII.A, CATT183 describes solutions for resolving collisions between retransmission of a first voice packet and initial transmission of a second voice packet on a single UE in E-UTRAN by directing them to different predefined persistent resources. Ex-1005, 2-3. When a collision would occur between such transmissions, the UE retransmits the first packet using

the same persistent resource that was used for prior transmissions of the first packet (the first predefined resource) and transmits the second packet using the other persistent resource (the secondary predefined resource). Ex-1005, 2-3. The initial transmission of the second packet thus diverts to a different HARQ process from the first process associated with transmissions of the first packet. *Id.*, FIG. 3.

51. CATT183's proposed technique predefines the secondary resource even before identifying a scheduled collision. Nonetheless, I believe a POSITA would have understood that the secondary resource can alternatively be allocated according to other well-known techniques. For example, Nokia476 describes a range of scheduling options including "dynamic" scheduling and "persistent" scheduling. Ex-1006, 1-4; *supra*, §VIII.B. Based on the teachings of Nokia476, I believe that CATT183's proposal for persistent scheduling of the secondary resource would have suggested to a POSITA that the secondary resource would be available to the UE on a regular basis, even before identifying a specific collision between retransmission of one packet and initial transmission of another. Ex-1006, §2.2.

52. A POSITA would have understood that persistent scheduling reduces control signaling overhead between the UE and eNB, and Nokia476 explains that dynamic scheduling offers certain comparative advantages relative to persistent scheduling and predefining resources. For example, dynamic scheduling typically

allows for more scheduling flexibility and results in more efficient resource allocation. Ex-1006, §2.1 (pp. 1-2) ("[d]ynamic scheduling … is naturally most flexible from the scheduling and UL resource usage point of view").

53. For the reasons explained in the following paragraphs, I believe it would have been obvious to modify CATT183's "Alt 2" solution according to Nokia476's suggestion for dynamic scheduling such that the secondary resource in the resulting system no longer would be persistently scheduled in advance as described in CATT18, but would instead be dynamically scheduled. In this First Predictable Combination, a POSITA would have predictably implemented the resulting CATT183-Nokia476 system such that the system would dynamically allocate the secondary resource to the UE only as needed to provide additional uplink capacity necessary to resolve a scheduled collision between a HARQ retransmission and an initial transmission of a next voice packet from a UE.

54. Based on my review, multiple reasons would have prompted a POSITA to combine the teachings of CATT183 and Nokia476 to provide for dynamic scheduling rather than predefined persistent scheduling of the secondary resource.

55. As a first reason motivating the combination, a POSITA would have recognized that dynamically scheduling the secondary resource would provide more efficient resource usage than predefining the secondary resource. With

dynamic scheduling, the secondary resource would be allocated only when needed to resolve an actual conflict between a pair of transmissions from a UE during a particular time transmission interval (TTI). Nokia476 even acknowledges that "[d]ynamic scheduling … is naturally most flexible from the scheduling and UL resource usage point of view." Ex-1006, §2.1

56. Furthermore, a POSITA would have understood that dynamic scheduling can reduce occurrences of unused/wasted resources that arise when a resource is predefined before ascertaining an actual need for the resource (which may never materialize). When there is no collision, dynamic scheduling ensures that the resource will not be pre-allocated to the UE to address a merely potential conflict that is never actually realized. Moreover, when the secondary resource is not pre-defined, the scheduler (e.g., at the eNB) can allocate the resource to other UEs as needed. Since a predefined secondary resource would not be tied to a specific UE before detecting a collision, fewer predefined resources may be allocated to UEs thereby increasing the pool of available/unused resources and potentially system performance when resources are scarce. Ex-1006, §§2.1, 2.3. A POSITA also would have seen that CATT183 acknowledges that the predefined secondary resource can be "dynamically scheduled to other service" when it is not needed. From this teaching, I believe a POSITA would have considered it beneficial to implement dynamic scheduling of the secondary resource in the first

instance to increase the availability of the resource to other UEs. Moreover, CATT183's disclosed approach of predefining the secondary resource and dynamically rescheduling the secondary resource when the secondary resource is not needed introduces certain complexity in its implementation that would be mitigated by the dynamic scheduling scheme that I have described in view of Nokia476. *See* Ex-1005, §2 ("implementation complexity will be increased").

57. As a second reason motivating the combination, dynamically scheduling the secondary resource would have enabled the system to achieve certain additional benefits that Nokia476 explains stem from dynamic scheduling. For instance, Nokia476 identifies "[f]lexible scheduling of VoIP and other users," "[s]cheduling freedom," "[f]requency and time selective scheduling," and "[f]ast and slow link adaptation" as advantages of dynamic scheduling schemes Ex-1006, §2.1 (pp. 1-2).

58. As a third reason motivating the combination, I believe a POSITA would have found that implementing CATT183 according to Nokia476's suggestion for dynamic scheduling would have been predictable since it involve the mere application of well-known techniques (Nokia476's dynamic scheduling) to a known system (CATT183) to yield predictable results with high expectation of success. CATT183 already acknowledged the feasibility of dynamic resource

allocation when there is no collision and Nokia476 provides additional detail regarding this predictable approach.

59. As a fourth reason motivating the combination, a POSITA would have found Nokia 476's suggestion for dynamic scheduling obvious to try in the context of CATT183. There were a finite set of options for allocating resources to an uplink transmission, which can be broadly characterized as either pre-allocating the resource or dynamically allocating the resource on an as-needed basis. In view of these two predictable options, a POSITA would have found it obvious to try dynamic allocation in CATT183 to achieve the predictable benefits associated with such an approach as described above. Ex-1006, §2.1; *see also id.*, §2.3.

B. Second Predictable Combination Overview

60. In §IX.A, I described a First Predictable Combination of the teachings of CATT183 and Nokia476 in which the secondary resource is not predefined but is instead allocated dynamically (without predefining the secondary resource before identifying a collision). Alternatively, based on my review, it would have been obvious to implement CATT183 according to Nokia476's suggestion for dynamic resource allocation in a second predictable manner that actually maintains use of CATT183's predefined secondary resource. Ex-1005, 2-3 (Alt 2 solution).

61. Recall that CATT183 proposed to "[a]llocate two persistent resources to voice packet in adjacent uplink subframes, named 'primary predefined resource'

and 'secondary predefined resource.'" Ex-1005, §2.2 ("Alt 2"). However, CATT183 also acknowledges that when there is no second retransmission of a first voice packet that would collide with the initial transmission of a second voice packet, then the "initial transmission [of the second voice packet] will use the primary predefined resource, and the secondary predefined resource can be dynamically scheduled to other service." *Id.* Although stated in a different context, a POSITA would have recognized CATT183's proposal for dynamically re-scheduling the secondary resource to another service to be similar to the practice described in Nokia476 for dynamically allocating unused resources to other services or other users. Ex-1006, §2.3 ("released resource can be allocated to some other VoIP user").

62. Based on my review, CATT183 does not expressly describe what happens to the secondary predefined resource after it is dynamically re-scheduled to another service. Clearly, however, the absence of a collision at one time does not imply that collisions will not arise in the future. It would therefore be beneficial to provide a capability to address future collisions after a predefined resource has been dynamically rescheduled (e.g., released) when no collision was identified at an earlier time. Considering the teachings of Nokia476,a POSITA would have found it predictable to dynamically re-allocate a secondary resource to

a UE upon detecting a subsequent collision—even when the secondary resource was initially predefined and then dynamically released. *Supra*, §IX.A.

63. Based on my review, a POSITA would have been motivated to re-allocate CATT183's secondary resource using dynamic allocation techniques based on Nokia476 for reasons similar to those I described with respect to the First Predictable Combination. *Supra*, §IX.A. For instance, by dynamically re-allocating a secondary resource to a UE after the secondary resource was previously released in response to identifying a scheduled collision, the likelihood of the secondary resource going unused will likely diminish thereby increasing the efficiency of resource usage in the system. Nokia476 also describes other known benefits of dynamic scheduling, including "[f]lexible scheduling," "[f]requency and time selective scheduling," and "[f]ast and slow link adaptation." Ex-1006, §2.1. Further, as I described above (§IX.A), dynamic resource allocation would have achieved predictable results and would have been obvious to try, particularly where the '480 patent's background discussion admits that dynamic resource allocation was already known to address collisions. Ex-1001, 2:27-32. Indeed, it would have been well understood among those working on LTE and reviewing CATT183 and Nokia476 that UEs would be noticed of resource allocations by PDCCH or predefined allocations.

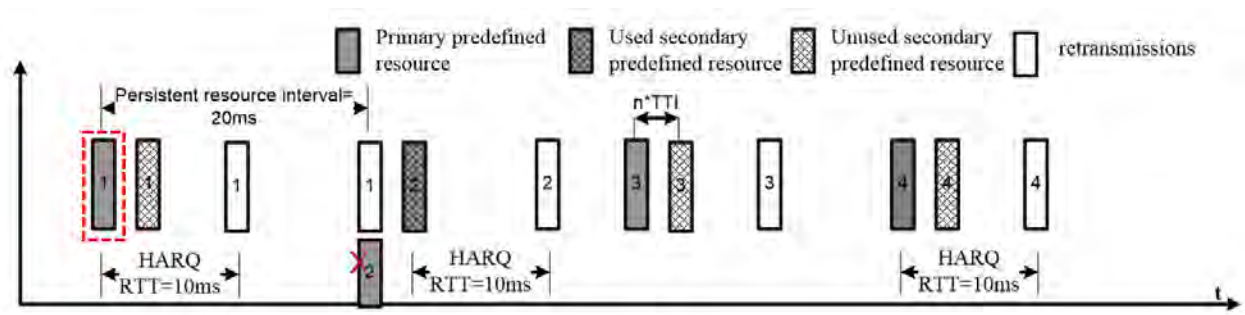
C. Analysis Of Claim Elements

[11.P]A method comprising:

64. CATT183 discloses in §2.2 (Alt 2) a method for collision resolution, and the First and Second Predictable CATT183-Nokia476 combinations described above provide the recited method. Ex-1005, 2-3; *supra*, §IX.A-B.

[11.1] transmitting a packet re-transmission in a hybrid automatic repeat request process using a semi-persistently scheduled uplink resource; and

65. CATT183 discloses transmitting a packet re-transmission in a first HARQ process using a persistently scheduled "primary" predefined uplink resource. Ex-1005, §2.2 (Alt 2).



Ex-1005, FIG. 1.

66. CATT183 further discusses that "semi-persistent scheduling has been adopted for VoIP" in E-UTRAN. *Id.*, §1. To the extent CATT183 does not expressly disclose that the primary resource in the "Alt 2" embodiment is "semi-persistently" scheduled, this feature was well known before October 5, 2007, and would have been obvious to apply to scheduling the primary resource in the resulting CATT183-Nokia476 combinations.

67. Nokia476 explains that semi-persistent scheduling involves automatic release of persistently scheduled resources, such as during "silence periods" of a voice session. Ex-1006, §2.3. It would have been obvious to implement the resulting First and Second Predictable combinations according to Nokia476's suggestion for semi-persistent scheduling such that the primary resource would be semi-persistently scheduled.

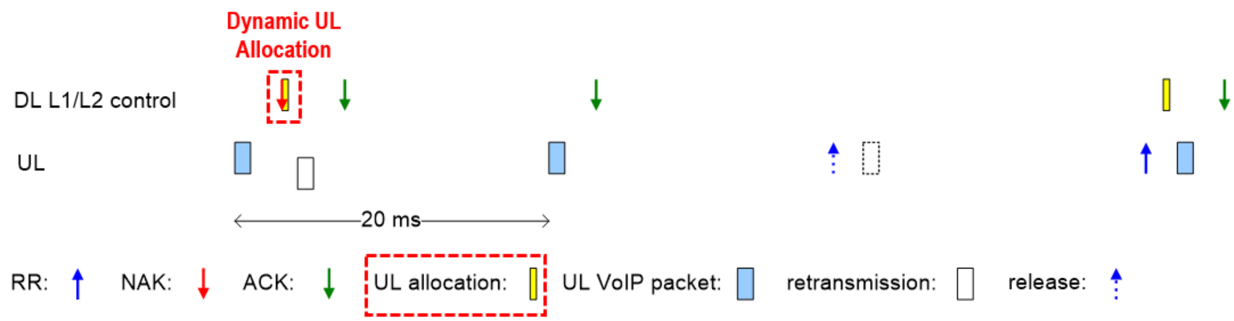
68. Based on my review, a POSITA would have sought to implement semi-persistent scheduling in this manner for several reasons. As a first reason, releasing the primary resource during silence periods would have advantageously allowed for more efficient resource usage because it would then be available to re-allocate to other users. As a second reason, semi-persistent scheduling was already commonly agreed upon in E-UTRAN (as admitted by CATT183), and it would have been predictable to adopt in the system in light of this agreement for purposes of achieving uniformity. As a third reason, the resulting combination would have achieved desired results consistent with the expected operation of semi-persistent scheduling as described in Nokia476.

[11.2] responsive to receiving a dynamic allocation of a different hybrid automatic repeat request process, transmitting a new packet using the dynamically allocated different hybrid automatic repeat request process.

69. CATT183 describes operations for predefining a secondary resource for a second (different) HARQ process to carry new packet transmissions in the event of a scheduled collision. Ex-1005, §2.2 (Alt 2).

70. To the extent CATT183 does not expressly disclose receiving a dynamic allocation of the second HARQ process, the First and Second Predictable CATT183-Nokia476 combinations would have achieved this feature based on Nokia476's suggestions for dynamic resource allocation.[1] Nokia 476 confirms that dynamic resource allocation was well-known in the context of semi-persistent scheduling. Ex-1006, §2.3. For instance, Figure 3 of Nokia476 shows the UE receiving a dynamically allocated uplink resource for retransmission of a packet that was not successfully received at the eNB:

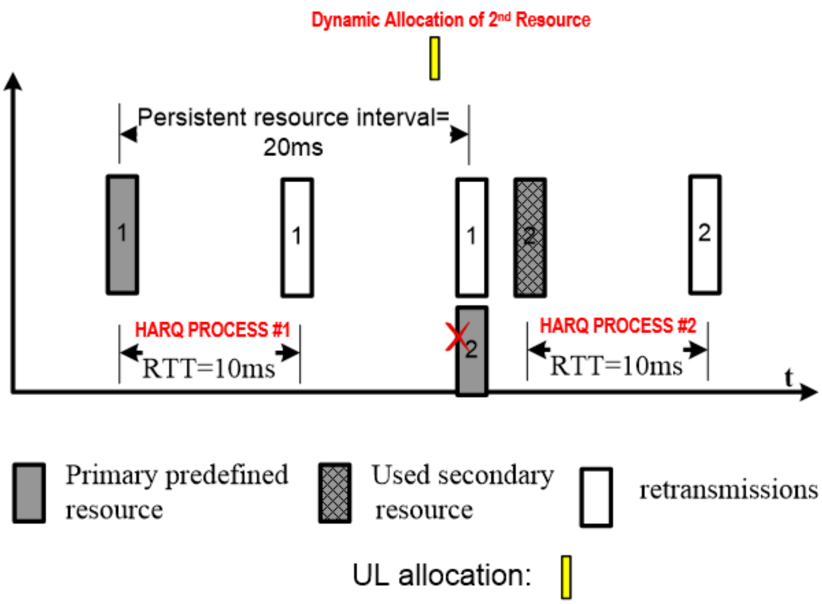
[1] For purposes of mapping prior art, counsel for Petitioner has instructed me treat "receiving a dynamic allocation of a different [HARQ] process," as recited in Element [11.2], as encompassing receipt of dynamically allocated resources for transmitting in a different HARQ process. *See, e.g.*, Ex-1001, 3:3-5, FIG. 7; Element [1.2].



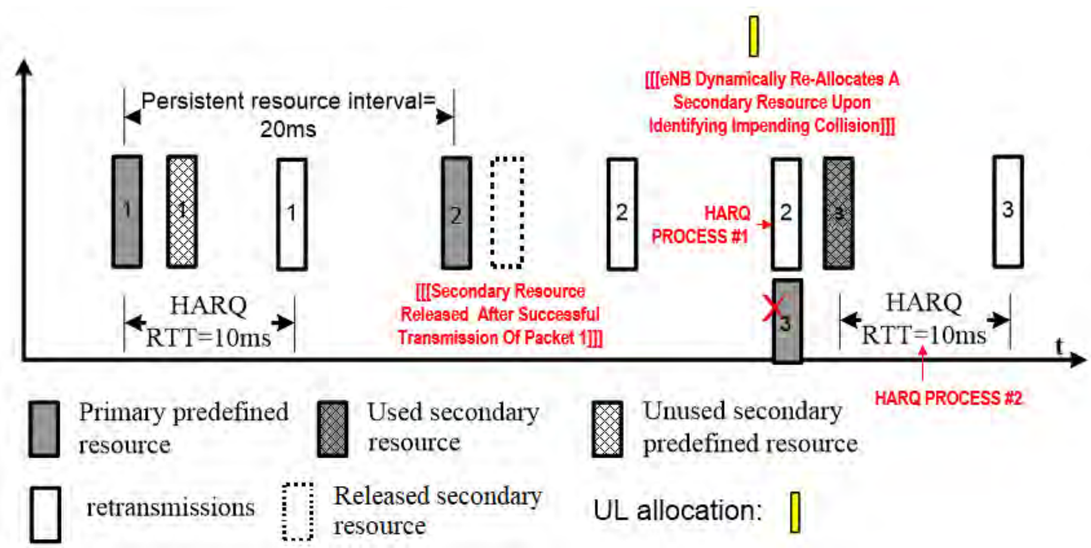
Ex-1006, FIG. 3 (annotated).

71. For the reasons that I explained in detail above (§§IX.A-B), it would have been obvious to implement CATT183's Alt 2 embodiment according to the teachings of Nokia476 for dynamic resource allocation. In both the First and Second Predictable CATT183-Nokia476 combinations, a UE in the resulting system predictably receives a dynamic allocation of the secondary resource for a second (different) HARQ process, and in response, transmits a new packet using the dynamically allocated secondary resource in the different HARQ process in a different subframe.

First Predictable Combination:



Second Predictable Combination



[12] The method according to claim 11, further comprising persistently allocating a resource for transmitting the new packet transmission in the different hybrid automatic repeat request process.

72. The additional feature recited in Element [12] would have been achieved by the CATT183-Nokia476 combination based on the following two mappings.

73. First, in the Second Predictable CATT183-Nokia476 combination described above (§IX.B), the secondary resource (corresponding to the recited "persistently allocat[ed] … resource") is predefined and persistently scheduled before being dynamically rescheduled to another user/service. The secondary resource in this instance is predefined, and is specifically provided for transmitting a new packet transmission in the second (different) HARQ process. Ex-1005, §2.2 (Alt 2), FIG. 3.

74. Second, CATT183 explains how "E-UTRAN allocates predefined resources for the first HARQ transmissions **<u>and potentially retransmissions to UEs</u>**." Ex-1005, §1 (emphasis added). This demonstrates that predefining both the initial transmission in a HARQ process and retransmissions was known, and was an approach that was even considered for the E-UTRAN standard at the time of the earliest possible priority date of the '480 patent (October 5, 2007). While the '480 patent does not expressly define what is meant by "persistently" allocated, by predefining a resource for both the initial transmission and retransmissions, the

present combination discloses this feature to at least the same extent as the ’480 patent. For example, with this approach, retransmissions do not need to be individually scheduled on a dynamic basis and so the resource persists for retransmissions. The ’480 patent does not mandate that the resource further persist for transmissions of subsequent packets. *See* Ex-1001, 7:7-11 (“[O]nly a new transmission that has collided with a re-transmissions need be dynamically scheduled to another HARQ process, as other new transmissions can occur in the persistent fashion in process #1 if the loading in HARQ process #1 is reasonable.”), 7:65-67, 8:14-17, 8:33-36. Based on CATT183, the secondary resource in both the First and Second Predictable CATT183-Nokia476 combinations would thus be persistently allocated for transmitting the new packet transmission in the different HARQ process.

[13] The method according to claim 11, wherein the dynamic allocation of the different hybrid automatic repeat request process is received from a network element.

75. Nokia476 discloses that the UE receives dynamically allocated resources from the Node B (e.g., eNB). Ex-1006, FIG. 3 (showing dynamic uplink resource allocation provided with NACK), (“allocation is sent either on L1/L2 control channel”); *generally* §§2.1 (“Node B allocates UL resource”), 2.3. As explained in detail above (§§IX.A-B), the UE in the predictable First and Second Predictable CATT183-Nokia476-CATT115 combinations receives the dynamic

allocation of the second (different) HARQ process from the eNB (corresponding to the recited "network element"). *Compare with* Ex-1001, 8:29-32, FIG. 8 (receiving dynamic allocation from eNB in '480 patent).

X. ANALYSIS OF COMBINATION BASED ON CATT183, NOKIA476, AND RANTA

[14.P]A computer readable medium encoded with a computer program executable by a processor to perform actions comprising:

76. The First and Second Predictable CATT183-Nokia476 combinations described above provide predictable techniques for resolving collisions in E-UTRAN. *Supra*, §§IX.A-B. To the extent CATT183 and Nokia476 do not expressly disclose the recited "computer readable medium," this feature would have been obvious in view of Ranta. For example, Ranta discloses a "UE 10 [that] includes a data processor (DP) 10A, a memory (MEM) 10B that stores a program (PROG) 10C …" Ex-1010, [0052]; *see also* [0053]-[0055], FIG. 1. Ranta also discloses the UE can include "a computer program product … that tangibly embodies a program of machine-readable instructions executable by a digital processing apparatus to perform operations." *Id.*, [0035], [0038], claims 17, 34.

77. I believe a POSITA would have found it obvious to further modify the First and Second Predictable CATT183-Nokia476 combinations according to Ranta's suggestions here such that the UE would include a computer-readable medium encoded with a computer program executable by a processor to perform

the actions of the UE described above in §§IX.A-B. A number of factors would have led a POSITA to implement the combination. For example, the computer-readable medium would have enabled the UE to execute actions for collision resolution and thereby achieve well-known benefits (e.g., more reliable delivery of packet transmissions and more efficient use of uplink resources). It also would have been predictable and natural to implement a computer-readable medium encoded with a computer program product as claimed since UEs ordinarily included computer-readable mediums in the relevant timeframe (e.g., October 5, 2007).

[14.1] transmitting a packet re-transmission in a hybrid automatic repeat request process using a semi-persistently scheduled uplink resource; and

78. This claim element would have been provided for the reasons I described above in §IX.C, Element [11.1].

[14.2] responsive to receiving a dynamic allocation of a different hybrid automatic repeat request process, transmitting a new packet using the dynamically allocated different hybrid automatic repeat request process.

79. This claim element would have been provided for the reasons I described above in §IX.C, Element [11.2].

[15] The computer readable medium encoded with a computer program of claim 14, where a resource is persistently allocated for transmitting the new packet transmission in the different hybrid automatic repeat request process.

80. This claim element would have been provided for the reasons I described above in §IX.C, Element [12].

[16] The computer readable medium encoded with a computer program of claim 14, where the dynamic allocation of the different hybrid automatic repeat request process is received from a network element.

81. This claim element would have been provided for the reasons I described above in §IX.C, Element [13].

XI. ANALYSIS OF COMBINATION BASED ON CATT183, NOKIA476, AND TS_36_300

[17.P] An apparatus comprising:

82. CATT183 discloses a UE as the recited "apparatus." Ex-1005, §§1, 2.2 (Alt 2); *see also* Ex-1006, §§2.1, 2.3; Ex-1009, §5.4.1.5, FIG. 5.4.1.5 (depicting UE); *supra*, §§IX.A-B.

[17.1] a hybrid automatic repeat request functional unit configured to transmit a packet re-transmission in a hybrid automatic repeat request process using a semi-persistently scheduled uplink resource; and

83. TS_36_300 discloses a HARQ functional unit in the UE, and confirms that HARQ functional units were standard UE components in E-UTRAN. Ex-1009, §5.4.1.5, FIG. 5.4.1.5 (depicting HARQ unit in UE). A POSITA would have implemented a HARQ functional unit in a UE in the CATT183-Nokia476-TS_36_300 combination for multiple reasons. For example, HARQ functional units were an expected part of the UE in E-UTRAN system in the relevant timeframe (e.g., October 5, 2007)—as confirmed by TS_36_300. Second, a POSITA would have appreciated that HARQ-related operations (such as the transmission recited in element [17.1]) would naturally be performed with a

HARQ functional unit since they fall within the scope of the HARQ functional unit's express purpose. *Id.*

84. As described in detail above (§IX.A-B and Element [11.1]), the HARQ functional unit would be configured to transmit a packet re-transmission in a HARQ process using a semi-persistently scheduled uplink resource. *supra*, §IX.A-B, §IX.C (Element [11.1]).

[17.2] responsive to receiving a dynamic allocation of a different hybrid automatic repeat request process, the hybrid automatic repeat request functional unit configured to transmit a new packet using the dynamically allocated different hybrid automatic repeat request process.

85. The operations for receiving a dynamic allocation of a resource for a different HARQ process, and transmitting a new packet using the dynamically allocated resource in the different HARQ process would have been obvious for the reasons explained above. *Supra*, §IX.C (Element [11.2]). It further would have been obvious to configure a HARQ functional unit in the UE to perform/facilitate these operations, for the reasons discussed in Element [11.1]. *Supra*, Element [11.1]; Ex-1009, §5.4.1.5, FIG. 5.4.1.5 (depicting HARQ unit in UE); *supra*, Element [11.2], §IX.A-B.

[18] The apparatus of claim 17, wherein the dynamic allocation comprises a resource is persistently allocated for transmitting the new packet transmission in the different hybrid automatic repeat request process.

86. This claim element would have been provided for the reasons I described above in §IX.C, Element [12].

[19] The apparatus of claim 17, further comprising a receiver configured to receive the dynamic allocation of the different hybrid automatic repeat request process from a network element.

87. TS_36_300 expressly confirms that the UE in an E-UTRAN system such as CATT183 includes a receiver for receiving transmissions from the eNB. TS_30_300, §5.4.1.5, FIG. 5.4.1.5 (depicting UE with receiver and antenna) ("receiver side"). The resulting CATT183-Nokia476-TS_36_300 combination would predictably include a receiver in the UE to receive the dynamic allocation of resources for a second/different HARQ process from the eNB (**network element**). *Supra*, §§IX.A-B, IX.C (Element [11.2]).

[20] The apparatus of claim 17, wherein the apparatus is embodied in a user equipment.

88. As described above (§IX.A-B), the apparatus is embodied in a user equipment (UE). *Supra*, Element [17.P], §IX.A-B; Ex-1009, §5.4.1.5, FIG. 5.4.1.5 (depicting UE).

XII. ANALYSIS OF COMBINATION BASED ON CATT183, NOKIA476, TS_36_300, AND CATT115

A. First Predictable Combination Overview

89. As I described in detail above (§IX.A), a POSITA would have found it obvious to modify CATT183 according to Nokia476's suggestion for dynamic resource allocation such that the secondary resource would not be predefined, but would rather be dynamically allocated in response to identifying a scheduled collision.

90. In my description above (§IX.A), I did not specifically detail how the system would detect a collision or the signaling between the UE and eNB that would be implicated in dynamically allocating the secondary resource. Nonetheless, it was known in the relevant timeframe of the ’480 patent (e.g., October 5, 2007) that the eNB could allocate uplink resources to a UE either in response to an explicit request from the UE (which I refer to as a “solicited” resource allocation) or in the absence of an explicit request from the UE (which I refer to as an “unsolicited” resource allocation). To illustrate, Nokia476 describes that in “fully dynamic scheduling” the “UE send[s] a resource request in UL for every VoIP packet,” and in “semi-persistent scheduling” the “UE [] send[s] a resource request” when “a talk spurt starts.” Ex-1006, §§2.1, 2.3. With semi-persistent scheduling, resource requests from the UE can result in a persistently scheduled resource for initial transmissions while “[a]ll [] retransmissions are allocated dynamically.” *Id.*, §2.3. The dynamic scheduling of retransmissions shows how the eNB can allocate uplink resources even when the UE does not explicitly resource request from UE. *Id.*

91. Based on my review, CATT115 confirms that unsolicited resource allocations were known and predictable to apply in the context of collision resolution. As described above in Section VIII.E, CATT115 describes techniques for dynamically allocating resources to address a collision that arises based on

synchronous HARQ and persistent scheduling. Ex-1007, §2.1; *supra*, §VIII.C. Specifically, when "the MAC scheduler becomes aware [] that [a] 2nd retransmission will conflict with persistent scheduling," "the scheduler notices the UE that the 2nd retransmission will continue in different resource units from previous retransmission by corresponding control signaling." *Id.*

92. A POSITA would have found it obvious to further modify the First Predictable CATT183-Nokia476 system (§IX.A) based on CATT115's suggestion for unsolicited resource allocations, and the resulting CATT183-Nokia476-CATT115 system would predictably be configured to dynamically allocate a secondary resource to the UE in an unsolicited manner in response to detecting a scheduled collision between a retransmission of a first packet and an initial transmission of a second packet. As described by Nokia476, the dynamic resource allocation would be sent to the UE on the downlink L1/L2 control channel (e.g., in a MAC control PDU) consistent with expected operation of an ordinary LTE system. *See* Ex-1006, §§2.1, 2.3. A number of reasons would have motivated a POSITA to apply CATT115's suggestion for unsolicited resource allocation in this First Predictable Combination for a number of reasons.

93. As a first reason motivating the combination, by implementing unsolicited allocation of CATT183's secondary resource according to the teachings of CATT115, the resulting system would have advantageously reduced the amount

of signaling overhead incurred relative to approaches that required the UE to send an explicit resource request to the eNB. In my experience, the benefits of reducing signaling overhead were well understood in the relevant timeframe of the ’480 patent (e.g., October 5, 2007), and tends to provide more efficient resource usage between the UE and eNB.

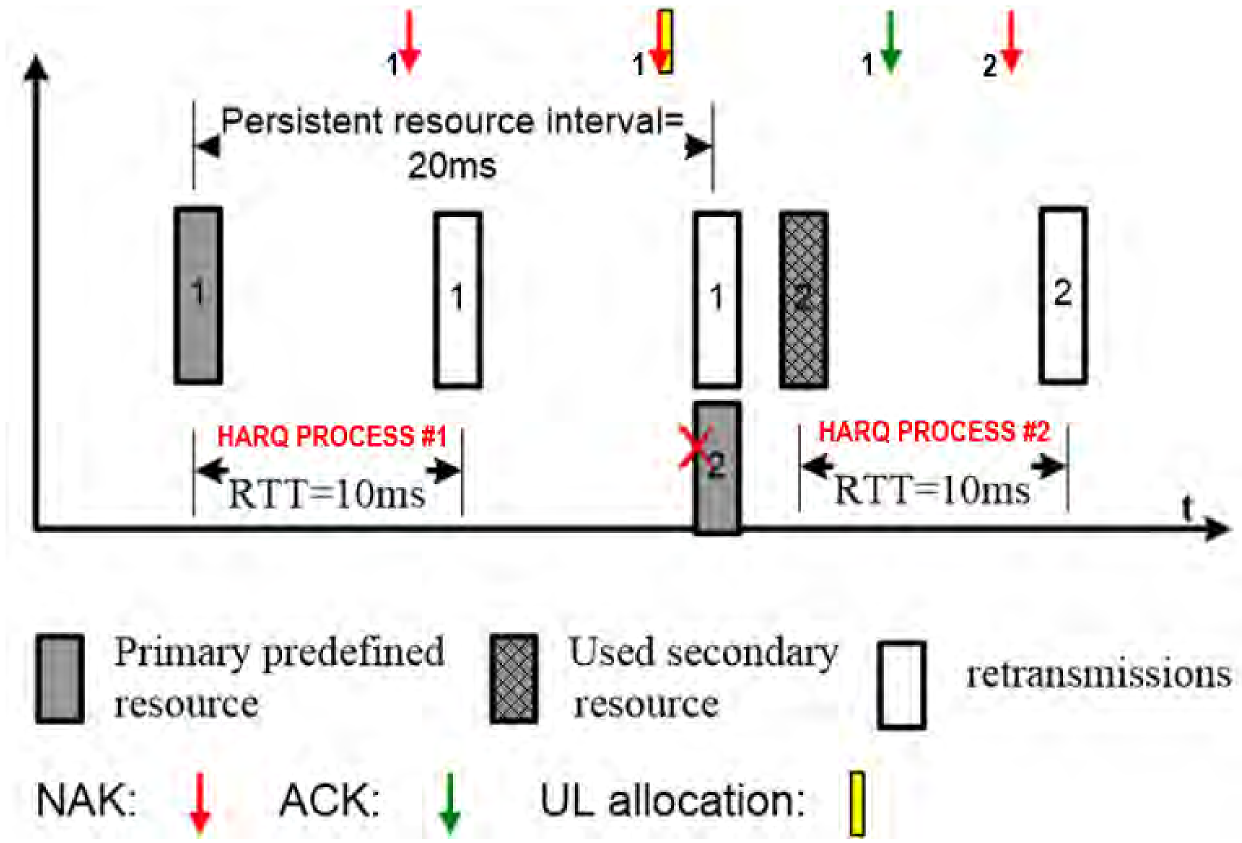
94. As a second reason motivating the combination, I also believe a POSITA would have found the eNB ideally positioned to detect collisions between transmissions and retransmissions from a UE. The eNB detects when it has not successfully received a prior uplink transmission, and thus already determines when packet retransmission is necessary. For example, Nokia476 shows how negative acknowledgments are sent from the eNB to UE when a packet is not successfully received. Ex-1006, §2.3. The eNB also tracks UE transmissions according to persistent scheduling and HARQ parameters. Therefore, a POSITA would have expected the eNB to be readily capable of identifying scheduled collisions and detecting the need for dynamic allocation of additional resources. Ex-1007, §2.1.

95. As a third reason motivating the combination, implementing the combined system according to CATT115’s suggestion for unsolicited resource allocation would have involved the mere application of a known technique

(CATT115's unsolicited resource allocation) to a predictable system (CATT183-Nokia476) to yield no more than predictable results.

96. Finally, a fourth reason motivating use of unsolicited resource allocation in the combination is that a POSITA would have found this approach obvious to try. In the relevant timeframe of the '480 patent (e.g., October 5, 2007), there were conceptually just two options for causing allocation of uplink resources to a UE: either in response to an explicit resource request from the UE or upon occurrence of some other condition indicating the need for an uplink resource other than the explicit request from the UE. In view of these two predictable options, it would have been obvious to try unsolicited allocations to realize the predictable benefits associated with this approach as described above.

97. The following illustration depicts an ordinary implementation of the First Predictable Combination as modified further in view of CATT115:



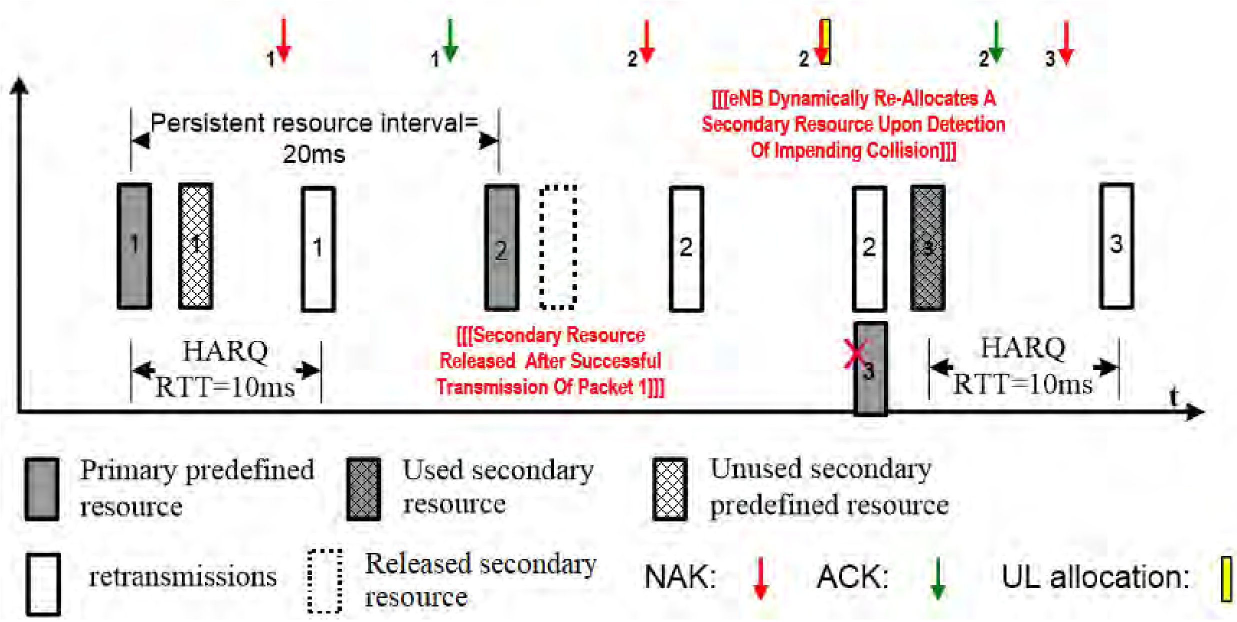
98. As shown above, in the First Predictable Combination, the system does not provide a predefined, persistently scheduled secondary resource. Instead, the eNB dynamically allocates the secondary resource in an unsolicited manner as needed upon detecting a conflict between the retransmission of first packet and a scheduled transmission of a second packet.

B. Second Predictable Combination Overview

99. As I described in detail above (§IX.B), a POSITA would have found it obvious to modify CATT183 according to Nokia476's suggestion for dynamic resource allocation such that a predefined secondary resource can be recovered after its release, upon identifying a scheduled collision. Further, in Section XII.A,

I described how CATT115 suggests the eNB can detect a scheduled collision and dynamically allocate resources in an unsolicited manner. *Supra*, §XII.A.

100. Based on my review, a POSITA also would have found it obvious to implement in the Second Predictable combination CATT115's suggestion for re-allocating the secondary resource to the UE by unsolicited notification when the eNB identifies detects a collision between a scheduled retransmission and initial transmission. Similar reasons would have motivated a POSITA to implement these suggestions in the Second Predictable Combination to the reasons that I described above with respect to the First Predictable Combination. *Supra*, §XII.A. For example, unsolicited resource allocation would have been beneficial to reduce signaling overhead that would otherwise be required for the UE to send an explicit resource request to the eNB. In addition, a POSITA would have appreciated that the eNB was well suited to detect scheduled collisions between transmissions and retransmissions from a UE, and as described above (§XII.A), unsolicited resource allocation would have achieved predictable results and would have been obvious to try. The following illustration depicts an ordinary implementation of the Second Predictable combination as modified further in view of CATT115:



C. Analysis Of Claim Elements

[1.P] A method comprising:

101. This claim element would have been provided for the reasons I described above in §IX.C, Element [11.P].

[1.1] detecting with a hybrid automatic repeat request function a collision between an uplink packet re-transmission and a new uplink packet transmission within a hybrid automatic repeat request process; and

102. As I described above (§VIII.A), CATT183's "Alt 2" embodiment (§2.2) discloses a system configured to identify a scheduled collision between an uplink packet-retransmission and a new uplink packet transmission within a first HARQ process using the primary predefined resource. Ex-1005, §2.2 ("If there is the 2nd retransmission of the last voice packet use the primary predefined resource, then the initial transmission of the current voice packet will use the secondary predefined resource."), FIG. 3; *supra*, §VIII.A. The '480 patent does not expressly

define what it means to detect a collision "within a HARQ process," but I believe CATT183 discloses a collision "within a HARQ process" at least to the same extent as the '480 patent itself. For example, CATT183 detects collisions that are scheduled or expected to occur in a same subframe or TTI from the same UE. Figure 1 of the '480 patent similarly depicts HARQ processes mapped to particular subframes from a same UE, and Figures 2-3 show alternating HARQ processes consistent with the description of Figure 1. Ex-1001, FIG. 1-3.

103. Additionally, as I explained in detail above (§§IX.A-B, XII.A-B), the predictable First and Second Predictable CATT183-Nokia476-CATT115 combinations specifically provide an eNB configured to perform the recited detection by identifying a scheduled collision between the uplink packet re-transmission and the new uplink packet transmission. *Supra*, §§IX.A-B, XII.A-B.

104. CATT115 further discloses a "MAC scheduler" at the eNB that "becomes aware [] that the 2nd retransmission will conflict with persistent scheduling." Ex-1007, §2.1. To the extent CATT183, Nokia476, and CATT115 do not expressly disclose the recited "[HARQ] function," (or HARQ functional unit), TS_36_300 confirms that such a function was an ordinary feature of eNBs in E-UTRAN at the time (e.g., October 5, 2007). Ex-1009, FIG. 5.4.1.5 (p. 29); *supra* §VIII.D. Based on my review, it would have been obvious to implement the First and Second Predictable CATT183-Nokia476-CATT115 combinations

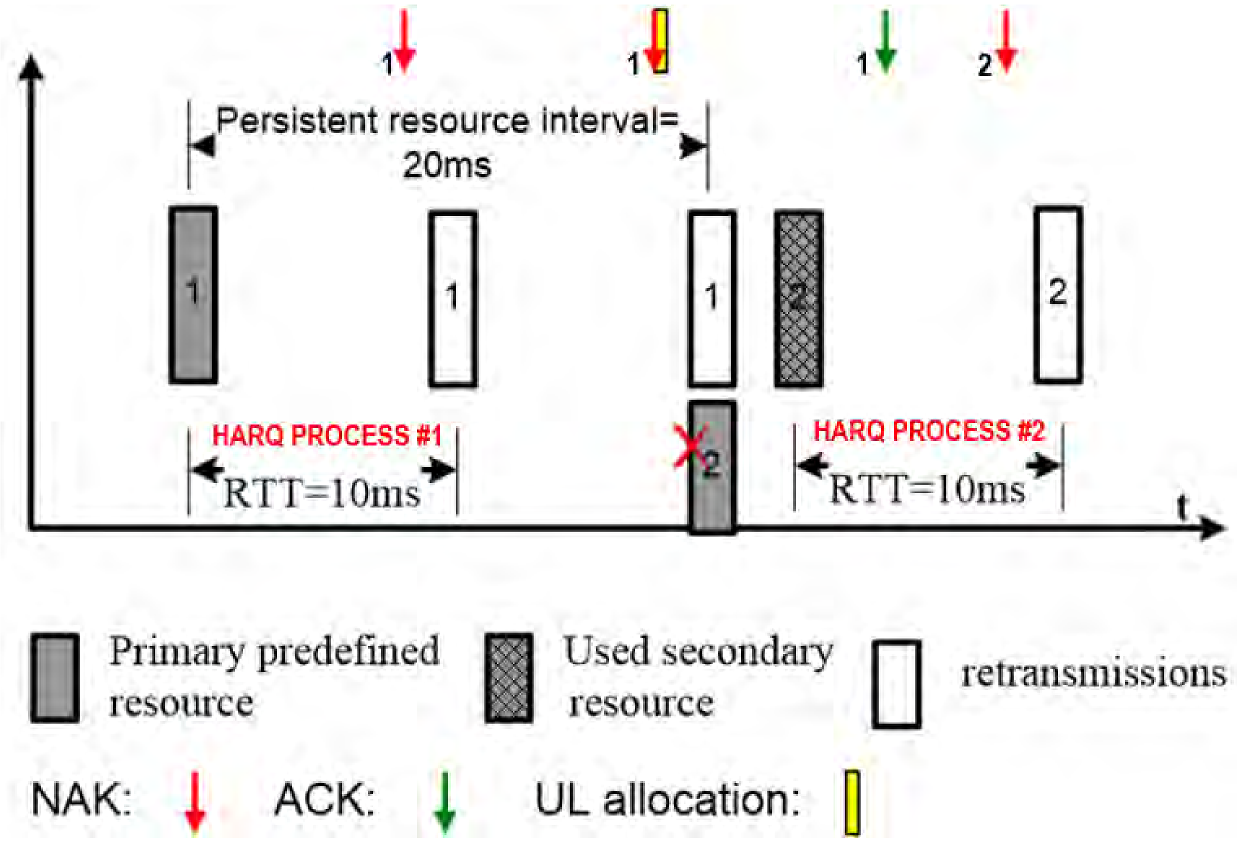
according to TS_36_300's suggestion for a HARQ function (or functional unit) such that the HARQ function in the resulting system would detect the collision (e.g., identify the scheduled collision) between the uplink packet re-transmission and the new uplink packet transmission within the first HARQ process in the primary resource and dynamically allocate resources to a HARQ process (as recited in element [1.2]).

105. Based on my review, a POSITA would have been prompted to implement this combination for multiple reasons. As a first reason motivating the combination, the HARQ function was a defined aspect of the eNB in the E-UTRAN system in the relevant timeframe (e.g., October 5, 2007)—as confirmed by TS_36_300. As a second reason motivating the combination, a POSITA would have appreciated that HARQ-related operations (such as the recited "detecting" and "dynamically allocating" operations) would naturally be performed using the HARQ function since HARQ operations are within the expected scope of a functional unit dedicated to HARQ. *Id.* As a third reason, the HARQ function is consistent with CATT115's suggestion for implementing a "MAC scheduler" since E-UTRAN provides "HARQ within the MAC sublayer." Ex-1007, §2.1; Ex-1009, §9.1 (p. 39). The resulting combination thus would have achieved predictable results consistent with typical use of a HARQ function, and a POSITA would have expected a high likelihood of success in implementing the combination.

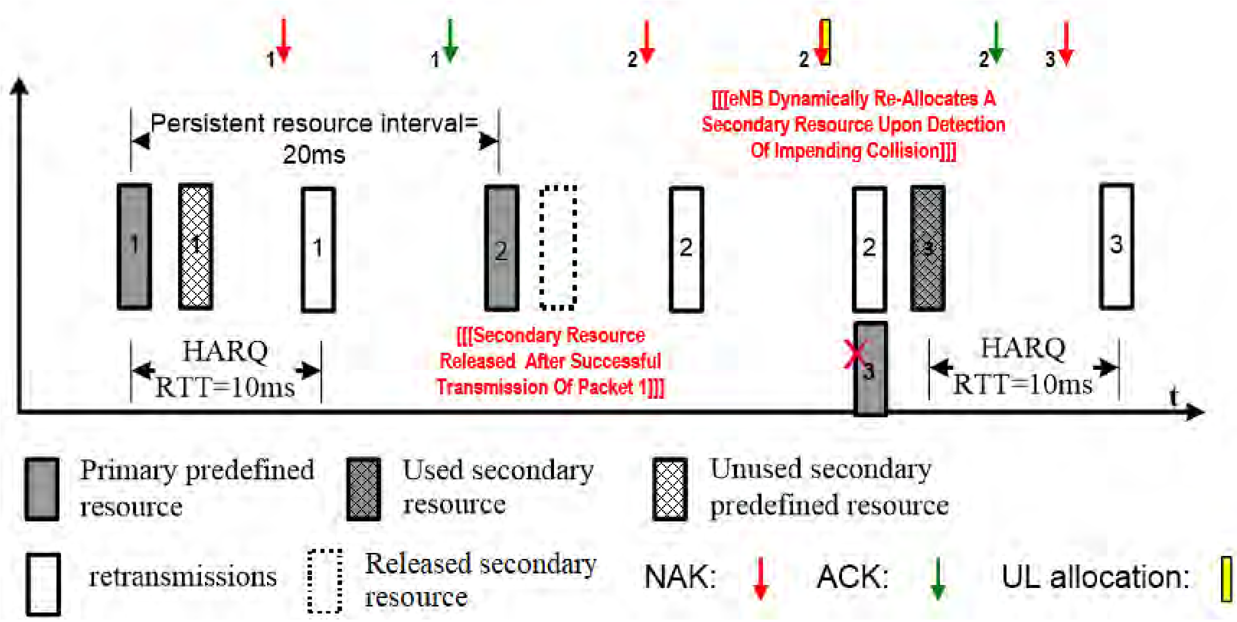
[1.2] in response, the hybrid automatic repeat request function dynamically allocating resources for transmitting the new uplink packet transmission in a different hybrid automatic repeat request process that does not collide with the uplink packet re-transmission.

106. CATT183's 'Alt 2' embodiment diverts the initial transmission of a second packet from a first HARQ process using a first predefined resource to a second HARQ process using a second predefined resource in a different subframe/TTI responsive to detecting a scheduled collision between the initial transmission of the second packet and a retransmission of a first packet in the first HARQ process. Ex-1005, §2.2 (Alt 2); *supra* §VIII.A. Nokia476 further discloses dynamic resource allocation, and CATT115 suggests use of dynamic resource allocations to avoid collision between retransmissions and initial transmissions in a HARQ process. Ex-1006, §§2.1, 2.3; Ex-1007, §2.1. For the reasons described in detail above (§§IX.A-B, XII.A-B), it would have been obvious to combine the teachings of CATT183, Nokia476, and CATT115, and the resulting First and Second Predictable combinations would have dynamically allocated, in response to detecting an impending collision (*supra* Element [1.1]), a secondary resource for transmitting the new uplink packet transmission in a different (second) HARQ process that does not collide with the uplink packet re-transmission in the first HARQ process. Based on TS_36_300, it further would have been predictable for these functions to be performed with a HARQ function at the eNB (as explained above (Element [1.1])).

First Predictable Combination:



Second Predictable Combination:



[3] The method according to claim 1, wherein the allocated resources are sent on a physical downlink control channel to a user equipment.

107. Nokia476 teaches that uplink resource allocations in E-UTRAN are sent over the DL L1/L2 control channel (**<u>physical downlink control channel</u>**). Ex-1006, §2.3 ("allocation is sent [] on L1/L2 control channel"), ("allocated dynamically using the L1/L2 control channel"), FIG. 3, §2.1 ("L1/L2 control signaling"), FIG. 1. As described above (§IX.A-B, XII.A-B), the predictable CATT183-Nokia476-TS_36_300-CATT115 combinations would have provided for the allocated resource to be sent on the DL L1/L2 control channel according to Nokia476's suggestion. *Supra*, §IX.A-B, XII.A-B; *infra*, §XV (Element [3]).

[4] The method according to claim 1, wherein the method is executed by a network element.

108. As I described in detail above (§IX.A-B, XII.A-B), the methods of both First and Second Predictable CATT183-Nokia476-TS_36_300-CATT115 combinations are executed by a network element such as an eNB with a HARQ function in an E-UTRAN system. Ex-1007, §2.1 ("MAC scheduler"); Ex-1009, §5.4.1.5, FIG. 5.4.1.5 (depicting eNB); Ex-1006, §§2.1, 2.3 ("Node B"); *supra*, §IX.A-B.

[7.P] An apparatus comprising:

109. According to the teachings of CATT183 and TS_36_300, the CATT183-Nokia476-CATT115-TS_36_300 combinations provide the recited

"apparatus," as an eNB or a component of the eNB that implements MAC/HARQ functions. Ex-1005, §2.2 (Alt 2); Ex-1009, §5.4.1.5; *supra*, §IX.A-B.

[7.1] a hybrid automatic repeat request functional unit configured to detect with a hybrid automatic repeat request function, a collision between an uplink packet re-transmission and a new uplink packet transmission within a hybrid automatic repeat request process; and

110. This claim element would have been provided for the reasons I described above in Element [1.1].

[7.2] in response, the hybrid automatic repeat request functional unit being configured to dynamically allocate resources for transmitting the new uplink packet transmission in a different hybrid automatic repeat request process that does not collide with the uplink packet re-transmission.

111. This claim element would have been provided for the reasons I described above in Element [1.2].

[8] The apparatus according to claim 7, wherein the apparatus is embodied in a network element.

112. TS_36_300 teaches that the apparatus that implements MAC scheduling and HARQ functions is embodied in the eNB (**<u>network element</u>**). Ex-1009, §5.4.1.5, FIG. 5.4.1.5; *supra*, Element [1.P], §IX.A-B.

[9] The apparatus according to claim 7, wherein resources are persistently allocated for transmitting the new uplink packet transmission in the different hybrid automatic repeat request process.

113. This claim element would have been provided for the reasons I described above in §IX.C, Element [12].

[10] The apparatus according to claim 7, wherein the allocated resources are sent on a physical downlink control channel to a user equipment.

114. This claim element would have been provided for the reasons I described above in Element [3].

XIII. ANALYSIS OF COMBINATION BASED ON CATT183, NOKIA476, TS_36_300, CATT115, AND RANTA

[5.P] A computer readable medium encoded with a computer program executable by a processor to perform actions comprising:

115. Ranta discloses the recited "computer readable medium." Ex-1010, [0052]; *see also* [0053]-[0055], FIG. 1; *supra*, §VIII.C. It would have been obvious to further modify the CATT183-Nokia476-CATT115-TS_36_300 in view of Ranta such that the UE and eNB would provide computer-readable media encoded with a computer program product according to Ranta's suggestion for at least the reasons described in §X, Element [14.P].

[5.1] detecting with a hybrid automatic repeat request function a collision between an uplink packet re-transmission and a new uplink packet transmission within a hybrid automatic repeat request process; and

116. This claim element would have been provided for the reasons I described above in §XI.B, Element [1.1].

[5.2] in response, the hybrid automatic repeat request function dynamically allocating resources for transmitting the new uplink packet transmission in a different hybrid automatic repeat request process that does not collide with the uplink packet re-transmission.

117. This claim element would have been provided for the reasons I described above in §XI.B, Element [1.2].

[6] The computer readable medium encoded with a computer program according to claim 5, where resources are persistently allocated for transmitting the new uplink packet transmission in the different hybrid automatic repeat request process.

118. This claim element would have been provided for the reasons I described above in §IX.C, Element [12].

XIV. ANALYSIS OF COMBINATION BASED ON CATT115, KUUSELA, AND TS_36_300

A. Combination Overview

119. Although CATT115 proposes in §2.1 a method of addressing collisions in synchronous HARQ "by changing the resource unit assignment of special retransmission that will conflict with other transmission," CATT115 lacks detail about changing the "resource unit assignment." *Supra*, §VIII.E. CATT115 also does not expressly disclose that the dynamically allocated resources are scheduled for a different HARQ process. *Id.*

120. Based on my review, a POSITA would have found it obvious to look to Kuusela for a predictable solution in this regard. *Supra*, §XIII. As I described above (§VIII.F), Kuusela describes techniques for resolving collisions that occur within a first HARQ process by diverting one of the conflicting transmissions to a second process in a different timeslot. Ex-1007, [0023]-[0025]. The suggestion to divert a conflicting transmission to a different HARQ process would have been obvious to apply in the context of CATT115's proposed solution. For instance, Kuusela teaches that CATT115's suggestion for changing the resource unit

assignment of a conflicting transmission can predictably involve diverting the transmission to a second HARQ process in a different timeslot from when the collision was otherwise scheduled to occur.

121. Based on my review, several reasons would have led a POSITA to modify CATT115's system according to Kuusela's suggestion for diverting a conflicting transmission to a different HARQ process.

122. As a first reason motivating the combination, a POSITA would have appreciated that LTE (E-UTRAN) systems already provided support for multiple HARQ processes for separately managing transmissions of different uplink packets. It would have been predictable to direct a retransmission of a first packet and an initial transmission of a second packet to different HARQ processes based on Kuusela's suggestion since doing so would simply entail advantageously utilizing parallel HARQ processes in LTE according to their ordinary purposes.

123. As a second reason motivating the combination, by diverting a conflicting transmission to a separate HARQ process, the transmissions of the respective packets associated with a scheduled collision would benefit from independent management in the respective HARQ processes. For instance, retransmissions of a first packet can continue for so long as necessary and permitted by parameters of the HARQ process, while the second packet would be

subject to independent retransmissions as needed, thereby promoting reliable delivery mechanisms for both packets.

124. As a third reason, the combination would have involved the mere application of a known technique (Kuusela's diversion of a conflicting resource to a separate HARQ process) to a known system (CATT115's E-UTRAN) that was ripe for improvement, and would have yielded no more than predictable results.

125. Even though CATT115 describes an E-UTRAN system, while Kuusela's disclosure focuses on WCDMA systems (*see* Ex-1008, [0002]), I do not believe these differences would have deterred a POSITA from implementing the CATT115-Kuusela-TS_36_300 system in the manner that I've described herein. In my experience, aspects of the VoIP services and HARQ processes provided in these wireless systems were substantially similar, and a POSITA would have appreciated the relevance of Kuusela's teachings beyond the specific context of WCDMA (including in E-UTRAN). Ex-1008, [0033] ("numerous other embodiments"). Not only are the HARQ systems in WCDMA (also referred to as the Universal Mobile Telecommunications System [UMTS]) and LTE similar, they are both part of the same protocol layer, namely Medium Access Control. As such, they are specified by 3GPP specifications that address this protocol layer, which in the case of LTE is the 36.321 specification (see Exhibit 1013), and in the case of WCDMA, the 25.321 specification, available from 3GPP at

https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=1175. The "36" and "25" digits refer to the respective systems of LTE and WCDMA, while the "321" digits refer to the precise functionality the specification addresses, which for both specifications is medium access control. In fact, both specifications have "Medium Access Control (MAC) protocol specification" in their titles. Therefore, a POSITA would have readily considered the functionality of one generation of wireless technology to learn its applicability in the subsequent generation, including Kuusela's teachings about HARQ in WCDMA.

126. It is also notable that CATT115 resolves collisions by dynamically allocating new resources to the retransmission for the first packet while the initial transmission of the second packet is allowed to occur in the original resources provided according to persistent scheduling. *See* Ex-1007, FIG. 1. Nonetheless, as Kuusela teaches, collisions can be resolved by diverting either the first packet retransmission or the second packet initial transmission. Ex-1008, [0024] ("retransmission could be delayed by one 10 ms frame taking the place of a normally unused process"), [0025] ("[a]lternatively, the new transmissions could be delayed by one 10 ms frame, taking the place of normally unused process and without delaying the retransmission").

127. I believe a POSITA would have found it obvious to further modify CATT115 in view of Kuusela such that the system would dynamically allocate resources for the initial transmission of the next voice packet in a second HARQ process (rather than dynamically allocating new resources for the retransmission of the prior voice packet), and a POSITA would have been motivated to choose this option in particular for several reasons.

128. As a first reason, diverting the initial transmission for the new packet to a separate HARQ process would have been obvious to try. A POSITA would have recognized that there are only two options for moving one of the two transmissions, i.e., either the retransmission of the first packet will be diverted or the initial transmission of the second packet will be diverted. Given these two known options, it would have been obvious to implement a system that diverts the initial transmission as a matter of design choice and to achieve at least the various benefits described in the following paragraphs.

129. As a second reason, by diverting the initial transmission of the new packet, a POSITA would have recognized benefits in maintaining retransmission of the first packet in the same HARQ process in which it began. For instance, complexity associated with changing the first packet's HARQ process before successful receipt by the eNB would thus be avoided, and standard retransmission operations of the first HARQ process would be maintained.

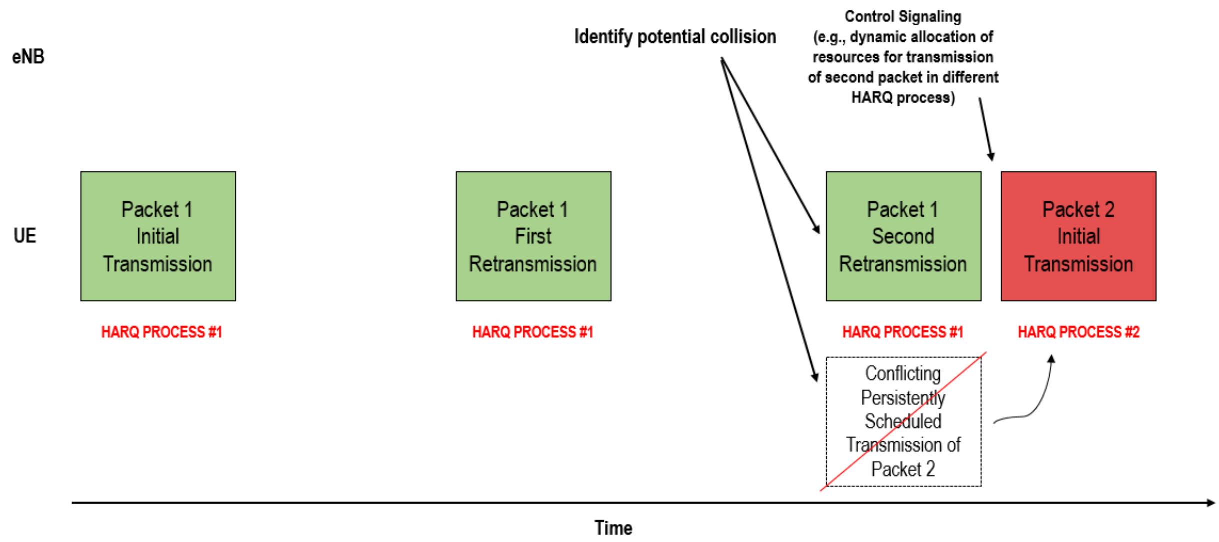
130. As a third reason, the combination would have involved the mere application of a known technique (Kussela's suggestion to divert an initial transmission to a separate HARQ process) to a known system (CATT115's E-UTRAN) that was ripe for improvement, and would have yielded no more than predictable results.

131. I also note that, by modifying CATT115 according to Kuusela's suggestion to divert the initial transmission of a new packet to the separate HARQ process rather than the re-transmission of a first packet, it is not necessary that the resulting system employ adaptive HARQ as provided in CATT115. Ex-1007, §2.1. Since retransmissions in the CATT115-Kuusela system are maintained in the same HARQ process, the system would not need to dynamically allocate resources for retransmissions. *Id.* Accordingly, CATT115's stated preference for non-adaptive HARQ would not have dissuaded a POSITA from implementing a system based on the teachings in §2.1 (regarding adaptive synchronous HARQ). *Id.* This is especially true since the options of adaptive and non-adaptive synchronous HARQ were still being studied for inclusion in the LTE standard in the relevant timeframe (e.g., October 5, 2007).

132. Furthermore, CATT115 discloses that the "MAC scheduler" of an eNB is the entity that identifies a scheduled collision and dynamically allocates different resources for a conflicting transmission. Ex-1007, 1. TS_36_300 further

describes the structure and functions of the eNB in E-UTRAN, and discloses a HARQ functional unit associated with the MAC scheduler. Ex-1009, p. 29; *see also id.*, §5.4.1.5. TS_36_300 also confirms that E-UTRAN implements HARQ within the "MAC sublayer," and so the MAC sublayer would include a HARQ function encompassing HARQ-related functions. Ex-1009, p. 39, §9. It would have been obvious to further modify CATT115-Kuusela based on TS_36_300 such that the HARQ function in the MAC sublayer of the eNB would handle HARQ-related tasks including detecting collisions and facilitating dynamic allocation and diversion of resources for the initial transmission of a packet from the UE in a different HARQ process. A POSITA would have been motivated to implement the resulting combination with a HARQ function in the eNB according to the suggestion of TS_36_300 for multiple reasons. For example, the resulting combination would be consistent with the eNB architecture explicitly provided in the LTE standard, the HARQ unit would be naturally well-suited to handle HARQ-related tasks consistent with its intended function, and a POSITA would have found that the resulting system achieves predictable results.

133. The following illustration depicts an ordinary implementation of a system resulting from the predictable combination of teachings from CATT115-Kuusela-TS_36_300:



B. Analysis Of Claim Elements

[1.P] A method comprising:

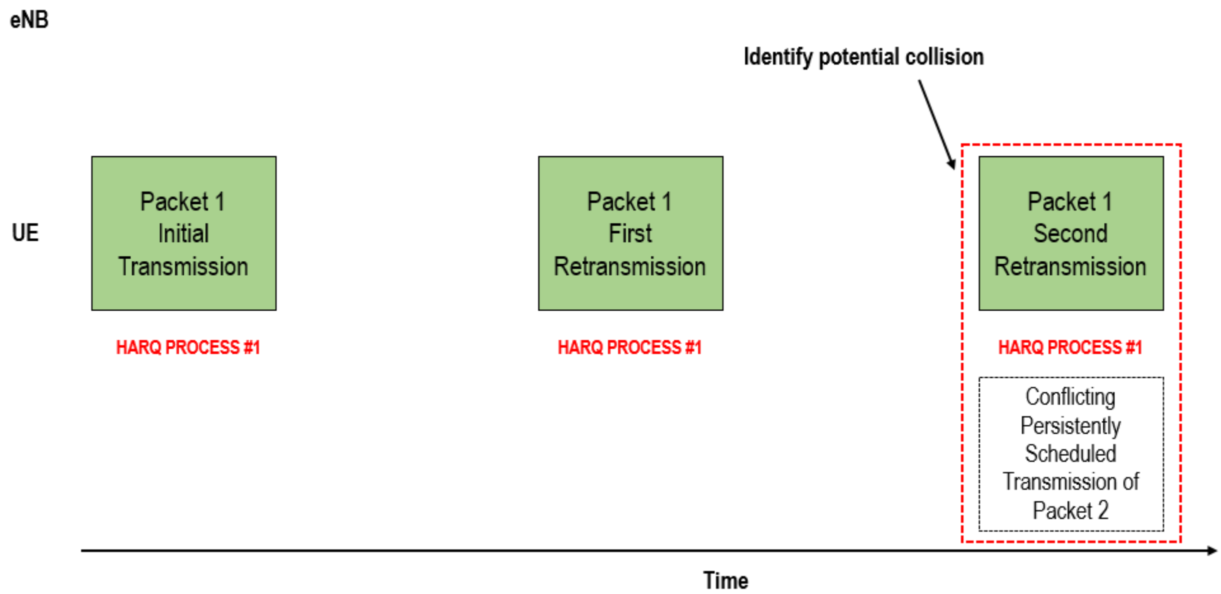
134. CATT115 discloses a method for collision resolution in E-UTRAN. Ex-1007, §2.1; *supra*, §XIV.A.

[1.1] detecting with a hybrid automatic repeat request function a collision between an uplink packet re-transmission and a new uplink packet transmission within a hybrid automatic repeat request process; and

135. CATT115 discloses that "collisions incurred due to synchronous operation can easily avoid [sic] by changing the resource unit assignment of special retransmission that will conflict with other transmission," and "after the 1st retransmission fails, the MAC scheduler becomes aware [] that the 2nd retransmission will conflict with persistent scheduling." Ex-1007, §2.1. Moreover, Kuusela discloses "a simple principle with VoIP service using a packet every 20 ms would be, for example, to allow transmission of only every second

ARQ process (odd or even)," while "taking into account an additional process for when retransmission is needed and there would be a conflict between the retransmission and the next packet arriving." Ex-1008, [0023]; *see also id.*, [0024]-[0025]. Furthermore, to the extent CATT115 does not expressly disclose a "HARQ function," TS_36_300 discloses such a "HARQ function" in the eNB. Ex-1009, FIG. 5.4.1.5 (p. 29); *supra* §VIII.D.

136. As I explained in detail above (§XIV.A), the predictable combination of CATT115-Kuusela-TS_36_300 would have detected (according to CATT115's and Kuusela's suggestions), with a HARQ function (according to TS_36_300's suggestion), a scheduled collision between an uplink packet re-transmission and a new uplink packet transmission within a HARQ process, as recited in claim 1. For example, the HARQ function at the eNB would detect a collision between a second retransmission and a persistently scheduled voice packet, as shown in the following figure:



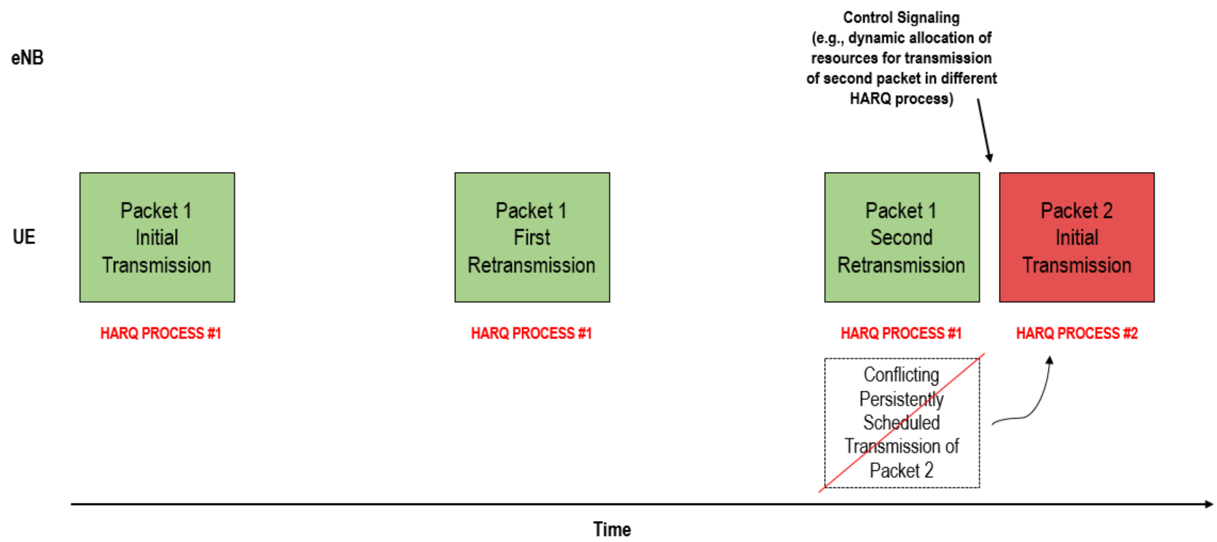
Supra, §XIV.A.

137. The ’480 patent does not expressly define what it means to detect a collision “within a HARQ process,” but I believe CATT115-Kuusela-TS_36_300 discloses a collision “within a HARQ process” at least to the same extent as the ’480 patent itself. For example, the resulting system would detect collisions that are scheduled or expected to occur in a same subframe or TTI from the same UE. Figure 1 of the ’480 patent similarly depicts HARQ processes mapped to particular subframes from a same UE, and Figures 2-3 show alternating HARQ processes consistent with the description of Figure 1. Ex-1001, FIG. 1-3.

[1.2] in response, the hybrid automatic repeat request function dynamically allocating resources for transmitting the new uplink packet transmission in a different hybrid automatic repeat request process that does not collide with the uplink packet re-transmission.

138. CATT115 discloses that, in response to detecting a scheduled collision, "the scheduler notices the UE that the 2nd retransmission will continue in different resource units from previous retransmission by corresponding control signaling." Ex-1007, §2.1. CATT115 does not expressly disclose that the resources are allocated for transmitting the new uplink packet in a different HARQ process, but Kuusela discloses these features. Ex-1008, [0023]-[0025]; *supra*, §VIII.F. TS_36_300 also discloses the well-known "HARQ function" defined in E-UTRAN at the eNB. Ex-1009, FIG. 5.4.1.5 (p. 29); *supra* §VIII.D.

139. For the reasons I explained in detail above (§XIV.A), it would have been obvious to modify CATT115 in view of Kuusela such that, in response to detecting a scheduled collision, the eNB dynamically allocates resources to the UE for transmitting the new uplink packet transmission in a different HARQ process in a different subframe that does not collide with the uplink packet re-transmission. Additionally, for the reasons explained above (§XIV.A), the eNB would predictably include a HARQ function (e.g., related to the MAC scheduler) to perform these operations.



[4] The method according to claim 1, wherein the method is executed by a network element.

140. CATT115 discloses, and the resulting CATT115-Kuusela-TS_36_300 combination provides, that the method is predictably executed by an eNB (**network element**). Ex-1007, §2.1 ("MAC scheduler"); *supra*, §§XIV.A.

[7.P] An apparatus comprising:

141. According to the teaching of CATT115 and TS_36_300, the resulting CATT115-Kuusela-TS_36_300 combination provides the recited "apparatus," as an eNB or a component of the eNB that implements MAC/HARQ functions . Ex-1007, §2.1 ("MAC scheduler"); Ex-1009, §5.4.1.5; *supra*, §XIV.A.

[7.1] a hybrid automatic repeat request functional unit configured to detect with a hybrid automatic repeat request function, a collision between an uplink packet re-transmission and a new uplink packet transmission within a hybrid automatic repeat request process; and

142. This claim element would have been provided for the reasons I described above in Element [1.1].

[7.2] in response, the hybrid automatic repeat request functional unit being configured to dynamically allocate resources for transmitting the new uplink packet transmission in a different hybrid automatic repeat request process that does not collide with the uplink packet re-transmission.

143. This claim element would have been provided for the reasons I described above in Element [1.2].

[8] The apparatus according to claim 7, wherein the apparatus is embodied in a network element.

144. TS_36_300 teaches that the apparatus that implements MAC scheduling and HARQ functions is embodied in the eNB (**network element**). Ex-1009, §5.4.1.5, FIG. 5.4.1.5; *supra*, Element [7.P], §XIV.B.

[9] The apparatus according to claim 7, wherein resources are persistently allocated for transmitting the new uplink packet transmission in the different hybrid automatic repeat request process.

145. TS_36_300 discloses "E-UTRAN can allocate a predefined uplink resource for the first HARQ transmissions **and potentially retransmissions to UEs**." Ex-1009, §11.1.2 (emphasis added); *see also* Ex-1005, §1. This demonstrates that predefining both the initial transmission in a HARQ process and retransmissions was known, and was an approach that was even considered for the

E-UTRAN standard at the time of the earliest possible priority date of the ’480 patent (October 5, 2007). While the ’480 patent does not expressly define what is meant by “persistently” allocated, by predefining a resource for both the initial transmission and retransmissions, the present combination discloses this feature to at least the same extent as the ’480 patent. For example, with this approach, retransmissions do not need to be individually scheduled on a dynamic basis and so the resource persists for retransmissions. The ’480 patent does not mandate that the resource further persist for transmissions of subsequent packets. *See* Ex-1001, 7:7-11 (“[O]nly a new transmission that has collided with a re-transmissions need be dynamically scheduled to another HARQ process, as other new transmissions can occur in the persistent fashion in process #1 if the loading in HARQ process #1 is reasonable.”), 7:65-67, 8:14-17, 8:33-36.

146. It would have been obvious to further modify the CATT183-Kuusela-TS_36_300 system according to TS_36_300’s suggestion for allocating a predefined uplink resource for both the initial transmission and retransmissions in the different (second) HARQ process. A POSITA would have sought to implement this predictable option to reduce the control signaling that would otherwise be required to dynamically allocate individual retransmissions.

XV. ANALYSIS OF COMBINATION BASED ON CATT115, KUUSELA, TS_36_300, AND NOKIA476

[3] The method according to claim 1, wherein the allocated resources are sent on a physical downlink control channel to a user equipment.

147. CATT115 discloses that "the scheduler notices the UE that the 2nd retransmission will continue in different resource units from previous retransmission **by corresponding control signaling**." Ex-1007, §2.1 (emphasis added), FIG. 3 ("control signaling"); *see also id.*, ("transmitter may change some or all of the transmission attributes"). To the extent CATT115 does not expressly disclose details of the control signals or how the allocated resources are sent to the UE, Nokia476 teaches that uplink allocations for E-UTRAN in this context are ordinarily sent over the DL L1/L2 control channel (**physical downlink control channel**). Ex-1006, §2.3 ("allocation is sent [] on L1/L2 control channel"), ("allocated dynamically using the L1/L2 control channel"), FIG. 3, §2.1 ("L1/L2 control signaling"), FIG. 1.

148. Based on my review, it would have been obvious to apply Nokia476's suggestion (allocating uplink resources on DL L1/L2 control channel) to the predictable CATT115-Kuusela-TS_36_300 combination (*supra*, §XIV.A) such that the dynamically allocated resources for the new packet transmission in the different (second) HARQ process are sent on the DL L1/L2 control channel. A POSITA would have been motivated to implement the system in this manner, especially since E-UTRAN provided efficient mechanisms for transmitting control signaling on the L1/L2 control channel, and it was the ordinary method of

dynamically allocating uplink resources in the relevant timeframe (e.g., October 5, 2007) according to applicable standards. Ex-1006, §2.3.

[10] The apparatus according to claim 7, wherein the allocated resources are sent on a physical downlink control channel to a user equipment.

149. This claim element would have been provided for the reasons I described above in Element [3].

XVI. ANALYSIS OF COMBINATION BASED ON CATT115, KUUSELA, TS_36_300, AND RANTA

[5.P] A computer readable medium encoded with a computer program executable by a processor to perform actions comprising:

150. Ranta discloses the recited "computer readable medium." Ex-1010, [0052]; *see also* [0053]-[0055], FIG. 1; *supra*, §VIII.C. It would have been obvious to implement the CATT115-Kuusela-TS_36_300 system (e.g., the UE and eNB) with computer-readable media encoded with a computer program product according to Ranta's suggestion for at least the reasons described in §X, Element [14.P].

[5.1] detecting with a hybrid automatic repeat request function a collision between an uplink packet re-transmission and a new uplink packet transmission within a hybrid automatic repeat request process; and

151. This claim element would have been provided for the reasons I described above in §XIV.B, Element [1.1].

[5.2] in response, the hybrid automatic repeat request function dynamically allocating resources for transmitting the new uplink packet transmission in a different hybrid automatic repeat request process that does not collide with the uplink packet re-transmission.

152. This claim element would have been provided for the reasons I described above in §XIV.B, Element [1.2].

[6] The computer readable medium encoded with a computer program according to claim 5, where resources are persistently allocated for transmitting the new uplink packet transmission in the different hybrid automatic repeat request process.

153. This claim element would have been provided for the reasons I described above in §XIV.B, Element [9].

XVII. ANALYSIS OF COMBINATION BASED ON CATT115, KUUSELA, AND NOKIA476

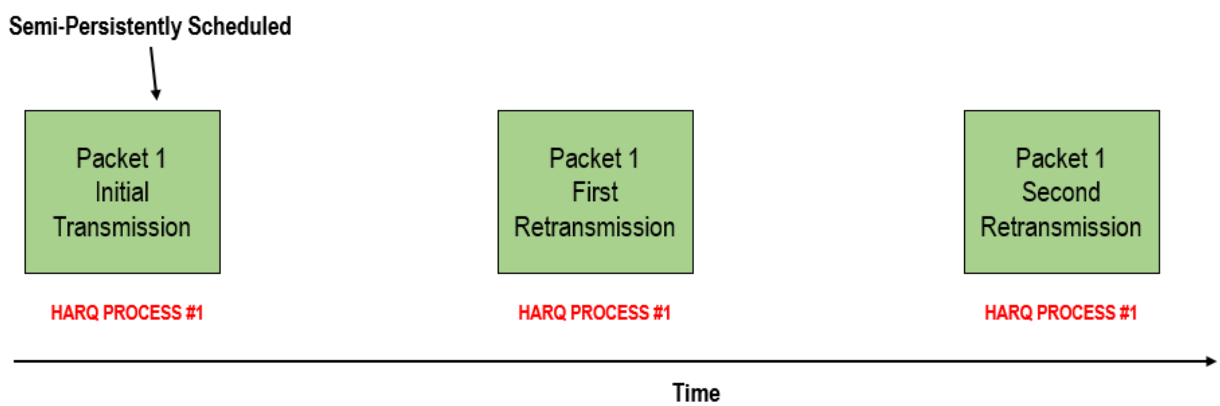
[11.P] A method comprising:

154. CATT115 discloses a method for collision resolution in E-UTRAN. Ex-1007, §2.1; *supra*, §XIV.A.

[11.1] transmitting a packet re-transmission in a hybrid automatic repeat request process using a semi-persistently scheduled uplink resource; and

155. CATT115 discloses transmitting a packet re-transmission in a HARQ process. Ex-1007, §2.1. To the extent CATT115 does not expressly disclose "using a semi-persistently scheduled uplink resource," Nokia476 demonstrates this feature was well-known in the relevant timeframe (e.g., October 5, 2007). For example, Nokia476 explains that semi-persistent scheduling allows for release of persistently scheduled resources during "silence periods" of a voice call. Ex-1006, §2.3.

156. Based on my review, a POSITA would have found it obvious to implement the resulting combination according to Nokia476's suggestion for semi-persistent scheduling. A POSITA would have been led to this approach for each of the reasons described above in the analysis of Element [11.1] (§IX.C). The following diagram shows an ordinary implementation of the CATT115-Kuusela-Nokia476 combination using semi-persistent scheduling according to Nokia476's suggestion:

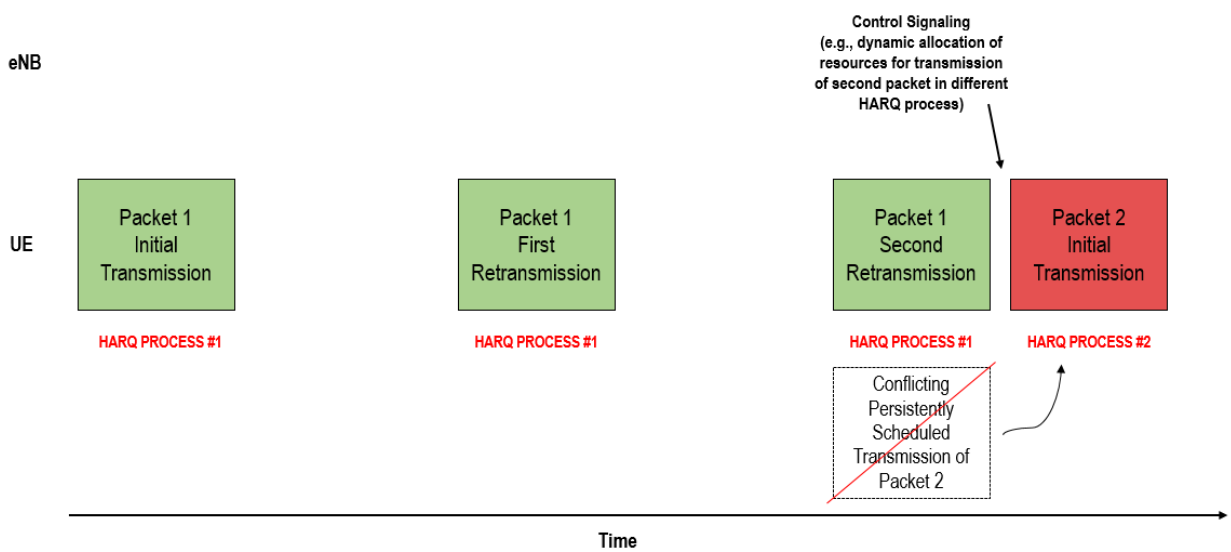


[11.2] responsive to receiving a dynamic allocation of a different hybrid automatic repeat request process, transmitting a new packet using the dynamically allocated different hybrid automatic repeat request process.

157. CATT115 discloses dynamic allocation of resource units to a UE for a second retransmission of a first packet such that the second retransmission does not interfere with an initial transmission of a new packet in the same resource units. Ex-1007, §2.1 ("scheduler notices the UE that the 2nd retransmission will continue in different resource units from previous retransmission"). The UE transmits a new packet using the different resource units in response to their dynamic

allocation. *Id.* To the extent CATT115 does not expressly disclose that the resources are for a different HARQ process or that the new packet (rather than the first packet) would be transmitted in the different HARQ process, Kuusela discloses these features. Ex-1008, [0023]-[0025]; *supra*, §VIII.F.

158. As I explained in detail above (§XIV.A), it would have been obvious to modify CATT115 in view of Kuusela such that the UE would receive from the eNB dynamically allocated resources for transmitting the new packet in a different HARQ process, and in response, transmitting a new packet using the dynamically allocated resources in a different HARQ process.



[13] The method according to claim 11, wherein the dynamic allocation of the different hybrid automatic repeat request process is received from a network element.

159. As described above with respect to Elements [11.1]-[11.2] and in §XIV.A, the UE in the CATT115 receives the dynamic allocation of resources for

transmission of the new packet in a second (different) HARQ process from an eNB (**network element**). Ex-1007, §2.1 ("MAC scheduler"); Ex-1006, §§2.1, 2.3 ("Node B"), FIGS. 1, 3; *supra*, Elements [11.1]-[11.2] and §XIV.A.

[14.P]A computer readable medium encoded with a computer program executable by a processor to perform actions comprising:

160. This claim element would have been provided for the reasons I described above in §XVI, Element [5.P].

[14.1] transmitting a packet re-transmission in a hybrid automatic repeat request process using a semi-persistently scheduled uplink resource; and

161. This claim element would have been provided for the reasons I described above in Element [11.1].

[14.2] responsive to receiving a dynamic allocation of a different hybrid automatic repeat request process, transmitting a new packet using the dynamically allocated different hybrid automatic repeat request process.

162. This claim element would have been provided for the reasons I described above in Element [11.2].

[16] The computer readable medium encoded with a computer program of claim 14, where the dynamic allocation of the different hybrid automatic repeat request process is received from a network element.

163. This claim element would have been provided for the reasons I described above in Element [13].

XVIII. ANALYSIS OF COMBINATION BASED ON CATT115, KUUSELA, NOKIA476, AND TS_36_300

[12] The method according to claim 11, further comprising persistently allocating a resource for transmitting the new packet transmission in the different hybrid automatic repeat request process.

164. Based on my review, CATT115-Kuusela-Nokia476 provides the method of claim 11. As described in detail above, TS_36_300 further discloses the additional feature recited in claim 12 to at least the same extent as the '480 patent itself. Ex-1009, §11.1.2 ("E-UTRAN can allocate a predefined uplink resource for the first HARQ transmissions and potentially retransmissions to UEs"); *supra*, §XIV.B (Element [9]). It would have been obvious to implement the system based on CATT115-Kuusela-Nokia476 according to TS_36_300's suggestion here for the reasons described above, and the resulting system would persistently allocate the uplink resource both for the initial and retransmissions of the new packet in the second (different) HARQ process. *Supra*, §XII.B.2 (Element [9]).

[15] The computer readable medium encoded with a computer program of claim 14, where a resource is persistently allocated for transmitting the new packet transmission in the different hybrid automatic repeat request process.

165. This claim element would have been provided for the reasons I described above in Element [12].

[17.P] An apparatus comprising:

166. The CATT115-Kuusela-Nokia476-TS_36_300 combination provides a UE as the recited "apparatus." Ex-1007, §2.1; Ex-1009, §5.4.1.5, FIG. 5.4.1.5; *supra*, §XIV.A.

[17.1] a hybrid automatic repeat request functional unit configured to transmit a packet re-transmission in a hybrid automatic repeat request process using a semi-persistently scheduled uplink resource; and

167. For the reasons that I described in detail above, the predictable CATT115-Kuusela-Nokia476 combination transmits a packet-retransmission in a HARQ process using a semi-persistently scheduled uplink resource. *Supra*, §XVII (Element [11.1]). To the extent these references do not expressly disclose a HARQ functional unit, TS_36_300 confirms that such a functional unit was ordinarily provided in a UE apparatus according to E-UTRAN standards. Ex-1009, §5.4.1.5, FIG. 5.4.1.5 (depicting HARQ unit in UE). It would have been obvious to implement CATT115-Kuusela-Nokia476 further based on TS_36_300 to provide a HARQ functional unit for at least the reasons identified above in the analysis of Element [17.1] (§XI).

[17.2] responsive to receiving a dynamic allocation of a different hybrid automatic repeat request process, the hybrid automatic repeat request functional unit configured to transmit a new packet using the dynamically allocated different hybrid automatic repeat request process.

168. The resulting system in the predictable CATT115-Kuusela-Nokia476 combination receives a dynamic allocation of resources for transmitting a new packet in a second/different HARQ process, and in response, transmits a new packet using the dynamically allocated resources in the second/different HARQ process. *Supra*, §XVI (Element [11.2]). It further would have been obvious to implement CATT115-Kuusela-Nokia476 further based on TS_36_300 to provide a

HARQ functional unit configured to perform HARQ related operations (including those recited in Element [17.2]), as described above. *Supra*, Element [17.1] (§XI).

[18] The apparatus of claim 17, wherein the dynamic allocation comprises a resource is persistently allocated for transmitting the new packet transmission in the different hybrid automatic repeat request process.

169. This claim element would have been provided for the reasons I described above in Element [12].

[19] The apparatus of claim 17, further comprising a receiver configured to receive the dynamic allocation of the different hybrid automatic repeat request process from a network element.

170. The UE in the CATT115-Kuusela-Nokia476-TS_36_300 combination receives the dynamic allocation of resources for transmitting in the second/different HARQ process from an eNB (**network element**). *Supra*, §XVII (Element [11.1]-[11.2]). TS_36_300 confirms the UE includes a receiver for receiving information such as the dynamically allocated resources from the UE. TS_36_300, §5.4.1.5, FIG. 5.4.1.5 (depicting UE with receiver and antenna) ("receiver side").

[20] The apparatus of claim 17, wherein the apparatus is embodied in a user equipment.

171. CATT115 discloses the apparatus embodied in a user equipment (UE). Ex-1007, §2.1 ("notices the UE"); Ex-1009, §5.4.1.5, FIG. 5.4.1.5 (depicting UE).

XIX. CONCLUSION

172. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both (under Section 1001 of Title 18 of the United States Code).

Executed this 28th day of November, 2020.

Peter Rysavy

Peter Rysavy

APPENDIX A

Peter Rysavy – Curriculum Vitae

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Peter Rysavy is an expert in wireless technology, mobile computing, and data networking

Contents

1. Education:

BSEE, MSEE Electrical Engineering, Stanford University, 1979.

2. Work Experience

Rysavy Research. 1993 to Present: President

Peter Rysavy is president of Rysavy Research LLC, a consulting firm that has specialized in wireless technology and mobile computing since 1993. Projects have included evaluation of wireless technology capabilities, network performance measurement, reports on the evolution of wireless technology, spectrum analysis for broadband services, strategic consultations, system design, articles, courses and webcasts, and test reports.

Peter Rysavy has expertise in IEEE 802.11 (Wi-Fi), wireless hotspots, mesh networks, metro and municipal Wi-Fi, paging technology, 2G, 3G, 4G, 5G, IMT-Advanced, IMT-2020, Global System for Mobile Communications (GSM), General Packet Radio Service (GPRS), Enhanced Data Rates for GSM Evolution (EDGE), Universal Mobile Telecommunications System (UMTS), Code Division Multiple Access (CDMA), Wideband CDMA (WCDMA), High Speed Downlink Packet Access (HSDPA), High Speed Uplink Packet Access (HSUPA), High Speed Packet Access (HSPA), HSPA+, Long Term Evolution (LTE), LTE-Advanced, LTE-Advanced Pro, LTE-Licensed Assisted Access (LAA), LTE-U, CDMA2000, CDMA2000 1XRTT, Evolved Data Optimized (EV-DO), Bluetooth, WiMAX, IEEE 802.16 (IEEE 802.16e, IEEE 802.16m), wireless security, smartphones, smartphone operating systems, Mobile IP, Evolved Packet System (EPS), Evolved Packet Core (EPC), e-mail, wireless e-mail, browsers, mobile browsers, media gateways, orthogonal frequency division multiplexing (OFDM), orthogonal frequency division multiple access (OFDMA), voice over IP (VoIP), mobile video, wireless spectrum, spectrum sharing, spectral efficiency, capacity analysis, mobile computing architectures, and TCP/IP networking.

Patent Litigation

Peter Rysavy has worked in numerous cases, both as testifying and consulting expert. He has trial experience, reports, and depositions. See section 4 for details.

Analysis

Rysavy Research analyzes wireless technologies for capability, compatibility, interoperability, and intellectual-property considerations.

Training

Rysavy Research conducts wireless-technology training, both publicly and privately.

Testing and Reports

Rysavy Research tests, evaluates, and reports on all major wireless technologies.

Application Development and Deployment

Rysavy Research works with companies to define architectures, select vendors, perform pilots, and to deploy wireless systems and applications.

Clients (excluding confidential litigation cases) from 1993 to present include:

5G Americas, AltaVista, Anchorage Partners, Antenna Software, Apple, Arris, AT&T, AT&T Wireless, Aventail, Black Lowe & Graham, Bluetooth SIG, Broadbeam, Cingular Wireless, City of Seattle, CMP Media, Compression Laboratories, Coinstar, Comverse Network Systems, Cricket Wireless, Crosslink Capital, Customer Focused Strategies, Datacomm Research, CTIA – The Wireless Association, Data Communications Magazine, Datacomm Research, Delco Electronics, Epicenter, Epicron, Ericsson, Fish and Richardson, Fluke, Foley Lardner, GE, Gerson Lehrman Group, Gibson Dunn, Good, Google, GSMA, Hillman Company, Hobnob, Hughes Network Systems, IMS Expert Services, Informa, Information Week, Intel, IT World, iWindsurf, Juniper Networks, Kirkland & Ellis, Klarquist Sparkman, MCCI, Medtronic Physio-Control, Microsoft, Mobile Computing Promotion Consortium (MCPC), Mobile Future, Moffatt Thomas, NetMotion Wireless, Network Magazine, Network Computing Magazine, New York State Wireless Association, Nokia, Norcom Networks, Novatel Wireless, OmniSky, Pacific Commware, Portable Computer and Communications Association (PCCA), Portland State University, Powell and Gilbert, Research in Motion (RIM), Park and Associates, Quality in Motion, RKM Holdings, Rogers Communications, Ruckus Wireless, Sanyo, SkyGo, Sprint, Stratos Product Development Group, Superconductor Technologies, Symbian, T-Mobile, TCI, Teklicon, Tektronix, Teledyne Electronic Technologies, Traveling Software (LapLink), United Business Media, University of British Columbia, UCLA, US Department of Defense, Wells Fargo, White & Case, Whitworth Analytics, WiMAX Forum, Wireless Data Forum, Wireless Technology Association, WRQ, Xerox Palo Alto Research Center, and Xircom.

Wireless Technology Association. 2000 to 2016: Executive Director.

Managed all the logistics of a non-profit industry organization that that evaluated wireless technologies, investigated mobile communications architectures, and promoted wireless-data interoperability. Organized and moderated more than fifty industry workshops.

Traveling Software (LapLink), Bothell, WA, USA. 1992 to 1993: Vice President of Technology.

Researched and evaluated key technologies. Developed Traveling Software's wireless communications strategy for local area and wide area connections. Helped define overall product and technology directions. Prototyped new technologies. Collaborated with technology partners. Developed license agreements for sale and purchase of technology. Participated in strategic sales efforts. Frequently traveled around the US and Asia. Spoke at conferences. Attended and monitored standards efforts. Managed patent applications and patent issues.

Traveling Software (LapLink), Bothell, WA, USA. 1988 to 1992: Vice President, Research and Development.

Developed Traveling Software's Research and Development department. Recruited over thirty professionals, including managers, design engineers, quality assurance engineers and technical writers. Under my management, we implemented: documented design and quality assurance procedures; a version control system; complete archiving with off-site storage; regular performance appraisals; a bonus plan; and well defined career paths. This R&D organization successfully brought in house all strategic technology and also released numerous successful software products for the retail PC market, including LapLink, LapLink Mac, DOS Connect for the HP 95LX, Organizer Link for the Sharp Wizard, and PC Link for the Casio BOSS.

Fluke Corporation, Everett, WA, USA. 1979 to 1981 and 1983 to 1988: Program Manager, Project Manager, Design Engineer.

As program manager, managed marketing group to determine target markets, sales channels, positioning and promotion in support of Fluke's operator interface business. As project manager, managed development of an entire family of communications-oriented touch terminals. Fluke introduced the first member, the 1020 Touch Control Screen in May, 1986. Directed software (C code for 68000 family processor), digital hardware (surface mount, semi-custom IC's, computer aided engineering), package design (injection molded plastic parts, steel chassis), and manuals (in English, French, German and Japanese.) Coordinated many groups: design, manufacturing, purchasing, component engineering, and marketing. As design engineer from 1979 to 1981, designed hardware and firmware for various systems, including: RS-232 communications; IEEE-488 communications; RS-485 multi-drop communications; thermal printer interface; cartridge drive interface; vacuum display driver and keypad driver.

Other Work Experience:

Time Office Computers, Australia, 1981 to 1983: Ethernet networking, random-access memory, power supply hardware development.

Stanford University, USA, 1976-1979: software consulting services for university/industry collaborations.

Additional information:

Available at http://www.rysavy.com

3. Patents

Peter Rysavy is the co-inventor of US4929935A, Apparatus for aligning raster scanned image to touch panel, filed May 2, 1986.

Peter Rysavy is the co-inventor of US4941845 A, Data transfer cable, filed June 7, 1989.

4. Testifying and Consulting Experience in Litigation

Summary

Thirty-two cases as a testifying expert.

Court testimony as testifying expert in one patent-litigation trial.

Eight patent-litigation depositions.

One breach-of-contract litigation deposition.

Training in testifying. (Seak: *How to be an Effective Expert Witness*.)

Twenty-three expert declarations for Inter Partes Review (twelve patents).

Five expert reports on non-infringement (eleven patents).

Six expert reports on invalidity (nine patents).

Two expert reports on non-breach-of-contract.

Multiple additional cases as consulting expert.

Ongoing Patent-Litigation Cases (most recent on top)

Testifying expert on patent invalidity for Motorola. Details available upon request.

Testifying expert for Ericsson. Inter Partes Review. U.S. Patent No. 7,016,676. *Case no. IPR2020-00376.* Firm: Haynes and Boone, LLP. Declaration of December 22, 2019.

Testifying expert for RPX. Inter Partes Review. U.S. Patent 7,245,917. *Cases no. IPR2018-01387, IPR2018-01388.* Firm: Klarquist Sparkman. Declaration filed July 13, 2018. Declaration for opposition to motion to amend filed August 8, 2019.

Testifying expert for Microsoft. Inter Partes Review. U.S. Patent No. 6,664,891. *Case no. IPR2019-01188.* Firm: Klarquist Sparkman. Declaration filed June 11, 2019. Second declaration filed May 25, 2020.

Testifying expert for Microsoft. Inter Partes Review. U.S. Patent No. 7,016,676. *Case no. IPR2019-01116.* Firm: Klarquist Sparkman. Declaration filed May 29, 2019. Second declaration filed May 19, 2020.

Testifying expert for Microsoft. Inter Partes Review. U.S. Patent No. 6,993,049. *Case no. IPR2019-01026.* Firm: Klarquist Sparkman. Declaration filed May 6, 2019. Second declaration filed May 19, 2020.

Prior Patent-Litigation Cases as Testifying Expert (most recent on top)

Testifying expert for Verizon. Non-infringement, U.S. Patent No. 9,642,024. Firm: Holland & Knight. Expert report on non-infringement July 17, 2019. Deposed August 9, 2019. Motion for summary judgement granted September 18, 2019.

Testifying expert for Fossil, non-infringement and invalidity, U.S. Patent No 6490443, *Freeny v. Fossil, case no. 2:18-cv-00049.* Firm: Fish & Richardson. Expert report on non-infringement, May 13, 2019. Expert report on invalidity April 22, 2019. Deposed May 21, 2019. Parties settled.

Testifying expert for Fossil. Inter Partes Review. U.S. Patent 6,490,443. *Case no. IPR2019-00755.* Firm: Fish & Richardson. Declaration filed April 1, 2019.

Testifying expert for Microsoft. Inter Partes Review. U.S. Patent 9,531,657. *Case no. IPR2017-01411.* Firm: Klarquist Sparkman. Declaration filed May 8, 2017. On November 28, 2018, the Patent Trial and Appeal Board ruled all claims to be unpatentable.

Testifying expert for Arris. Non-infringement and invalidity (one patent), *Sony v. Arris, ITC No. 337-TA-1049.* Firm: Fish & Richardson. Expert report on non-infringement, October 13, 2017. Expert report on invalidity September 27, 2017. Case settled in December 2017.

Testifying expert for Microsoft. Inter Partes Review. U.S. Patent 8,848,892. *Case no. IPR2017-01052.* Firm: Klarquist Sparkman. Declaration filed March 9, 2017. Deposed November 30, 2017. On September 19, 2018, the Patent Trial and Appeal Board ruled all claims to be unpatentable.

Testifying expert for Apple, non-infringement (three patents) and invalidity (two patents), *Unwired Planet v. Apple, case No. 13-cv-04134.* Firm: Gibson Dunn. Expert report on non-infringement January 12, 2015. Expert report on invalidity December 3, 2014; rebuttal-reply report on invalidity January 26, 2015. Deposed February 13, 2015. Case settled in April 2017.

Testifying expert for Google, Inter Partes Review.

> U.S. Patent 5,809,428. *Case nos. IPR2017-00529, IPR2017-00530, and IPR2017-00559*. Three declarations filed December 30, 2016. Firm: Fish & Richardson. Parties settled as of May 2017 and IPR proceedings terminated.
>
> U.S. Patent 5,754,946. *Case nos. IPR2017-00536 and IPR2017-00537*. Two declarations filed December 29, 2016. Firm: Fish & Richardson. Parties settled as of May 2017 and IPR proceedings terminated.
>
> U.S. Patent 5,894,506. *Case nos. IPR2017-00532, IPR2017-00533, IPR2017-00534, and IPR2017-00535*. Four declarations filed December 28, 2016. Firm: Fish & Richardson. Parties settled as of May 2017 and IPR proceedings terminated.

Testifying expert for RPX, Inter Partes Review.

U.S. Patents 8,135,342 and 8,879,987. *Case nos. IPR2016-01052, IPR2016-01053, and IPR2016-01054*. Declaration filed May 17, 2016. Firm: Klarquist Sparkman. January 2017, all IPRs were instituted on a majority of the claims in the petitions, and patent owner ultimately canceled all instituted claims.

U.S. Patents 8,135,342 and 8,879,987. *Case nos. IPR2016-00985 and IPR2016-00989*. Declaration filed April 30, 2016. Firm: Klarquist Sparkman. January 2017, both IPRs were instituted on a majority of the claims in the petitions, and patent owner ultimately canceled all instituted claims.

Testifying expert for Microsoft, invalidity and non-infringement (two patents), in *Eleven Engineering Inc. et al. v. Microsoft Corporation et al., No. 09-903-LPS (D. Del.).* Firm: Fish & Richardson. Plaintiff conceded to non-infringement based on claim construction July 2016 prior to report submission.

Testifying expert for LG Electronics, non-infringement (one patent), in *Cellular Communication Equipment LLC v. LG Electronics, Inc., et al., Case no. 6:13-cv-00508 (EDTX)*. Firm: Mayer Brown. Case settled July 2016 prior to report submission.

Testifying expert for T-Mobile, non-infringement (five patents), *Intellectual Ventures v. T-Mobile US*, case no. 1:13-cv-01632-LPS. Firm: Gibson Dunn. Expert report May 26, 2016. Deposed September 20, 2016. Parties settled.

Testifying expert for Amazon, Barnes & Noble, MediaTek, Nokia, Samsung, Texas Instruments, invalidity (one patent), in *CSIRO v. MediaTek et al., Case No. 6:12-cv-578-LED-KNM*. Firms: Covington & Burling, O'Melveny & Myers, Quinn Emanuel Urquhart & Sullivan, White & Case. Report on invalidity December 19, 2014. Deposed March 6, 2015. Case settled July 2015.

Testifying expert for Apple, invalidity (three patents) in *GPNE v. Apple*, *case no. 12-CV-02885-LHK*. Firm: Fish & Richardson. Report on invalidity January 4, 2014. Deposed February 20, 2014. Testified in court October 17 and October 20, 2014. Jury verdict of non-infringement on all three patents.

Testifying expert for HTC, invalidity (one patent), in *Nokia v. HTC, ITC Investigation No. 337-TA-847*. Firm: White & Case. Report 2013. Patent withdrawn from dispute.

Other Patent-Litigation Testimony

Claim-construction declaration for Microsoft in *Eleven Engineering Inc. et al. v. Microsoft Corporation et al., No. 09-903-LPS (D. Del.)*, January 28, 2016. Case details above.

Claim-construction declaration for Apple in *Unwired Planet v. Apple*, April 7, 2014. Case details above.

Declaration *"In re Patent Application of Han-Jin JOH, 11/266,114."* Docket No. P2481US00, April 18, 2012. Firm: H.C. Park & Associates, PLC.

Declarations for Front Row Technologies in *Inter Partes Reexam. 95/001,565*, April 4, 2011; *95/001,568*, March 7, 2011; *95/001,566*, March 4, 2011. Firm: Black, Lowe & Graham PLLC.

Breach-of-Contract Litigation

Testifying expert for Sprint, non-breach-of-contract, in *Truckstop.net vs. Sprint Communications*, Case No. CV-04-561-S-BLW. Firm: Moffatt Thomas. Report March 31, 2006, supplemental report September 28, 2006. Deposed May 3, 2007. Worked on case 2005 to 2010.

Consulting Expert History

Consulting expert for Maynard, Coper & Gale. SMS technology review, Pre-Lit IPR. 2018.

Consulting expert for T-Mobile in *Intellectual Ventures v. T-Mobile USA, No. 13-cv-1671, No. 14-cv-1232, No. 2:17-cv-00577-JRG.* Firm: Keker & Van Nest. 2016-2018.

Consulting expert for Huawei in UK litigation, *Unwired Planet International Limited v Huawei Technologies (UK) Co., Limited and others, Claim no. HP14 801038*. Firm: Powell Gilbert. 2015-2016.

Consulting expert for Nokia in *Mobile Enhancement Solutions LLC v. Nokia Corp. et al., 3:13-cv-03977-M*. Firm: King & Spalding. 2014.

Consulting expert for Amazon in *GPNE v. Amazon.com, et al. No. 1-11-CV-00426*. Firm: Klarquist Sparkman. 2012.

Consulting expert for Motorola in *Microsoft Corp. v. Motorola Mobility, Inc. - UK Litigation. Claim No. HCll C04536*. Firm: Powell Gilbert. 2012.

Consulting expert for Pantech in *GPNE v. Amazon.com, et al., No. 1-11-CV-00426*. Firm: HC Park & Associates. 2012.

Consulting expert for SkyTel (Verizon) in *EON Corp. IP Holdings, LLC v. SkyTel, et al., Case No. 3:08-CV-385.* Firm: Simpson, Thacher & Bartlett. 2009.

Consulting expert for Research in Motion in *Visto Corp. v. Research in Motion Corp.* Firm: Kirkland & Ellis. 2008.

Consulting expert for Starent Networks in *UT Starcom, Inc. v. Starent Networks, Corp, No. 07 CV 2582.* Firm: Finnegan, Henderson, Farabow, Garrett & Dunner. 2008.

Consulting expert for Apple in *Apple Computer/Creative Labs Patent Disputes*. Firm: Kirkland & Ellis. 2006.

Consulting expert for Samsung in *Reese v. Samsung Telecommunications America L.P. et al., Civil Action No. 2:05-CV-00415-DF*. Firm: Kirkland & Ellis. 2006.

Consulting expert for Sanyo in *Antor Media Corporation v. Nokia, Inc., Utstarcom Personal Communications, LLC, Audiovox Communications Corp., Kyocera Wireless Corp., Sanyo North America Corp., Sharp Electronics Corp., NEC America, Inc., Research In Motion Corp., Virgin Mobile USA, LLC, LG Electronics Mobilecomm U.S.A., Inc., Palmone, Inc., and Panasonic Corp. of North America, Case No. 2-05cv-186 LED.* Firm: Kirkland & Ellis. 2005.

Consulting expert for Sanyo in *Zoltar Satellite Systems, Inc. [sic] v. LG Electronics Mobile Communications Co., et al., 2:05-CV-002150 LED.* Firm: Foley & Lardner. 2005.

Consulting expert for Sanyo in *William Reber L.L.C. v. Samsung Electronics America, Inc., et al. Civ. Action No. 03 C 4174.* Firm: Foley Lardner. 2004.

5. Public Speaking

Peter Rysavy has spoken at more than 60 public events, such as conferences, as a keynote presenter, moderator, and panelist. See https://rysavy.com/speaking/ for details.

6. Published Articles and Reports

The more-than-190 articles, reports, and white papers by Peter Rysavy, listed from most recent to oldest, include the following:

1. "Global 5G: Rise of a Transformational Technology," September 2020. Report published by 5G Americasz.
2. "Latest Tech Aims to Solve Riddle for Rural Broadband," August 2020. Article for Fierce Wireless.
3. "6 GHz Should Be Allocated for Both Licensed and Unlicensed Applications," March 2020. Article for Light Reading.
4. "Virtualization Will Transform the Wireless Industry," December 2019. Article for Fierce Wireless.
5. "Global 5G: Implications of a Transformational Technology," September 2019. Report published by 5G Americas.
6. "How Title II Net Neutrality Undermines 5G," June 2019. Report published by Rysavy Research.
7. "How the 'Save the Internet' Act Breaks 5G," May 2019. Article for Bloomberg Law.
8. "Bad Idea of Nationalized 5G Network Put to Rest," April 2019. Article for Fierce Wireless.
9. "Untangling C-band for a New Broadband Future," January 2019. Article for Fierce Wireless.
10. "Broadband Disruption: How 5G Will Reshape the Competitive Landscape—Second Edition," November 2018. Report published by Datacomm Research.
11. "LTE to 5G: The Global Impact of Wireless Innovation," August 2018. Report published by 5G Americas.
12. "Mid-Band Spectrum for 5G Needed Now," August 2018. Article published by Fierce Wireless.
13. "Small Cells – Suddenly Essential," March 2018. Article published by RCR Wireless.
14. "How 5G Will Solve Rural Broadband," January 2018. Article published by Fierce Wireless.
15. "The Power of Wireless Broadband," November 2017. Report published by Rysavy Research.

16. "Broadband Disruption: How 5G Will Reshape the Competitive Landscape," August 2017. Report published by Datacomm Research.
17. "Why 5G Will Be a Game Changer," August 2017. Article published by Fierce Wireless.
18. "LTE to 5G: Cellular and Broadband Innovation," August 2017. Report published by 5G Americas.
19. Declaration of Peter Rysavy. Exhibit to CTIA Comments to Federal Communications Commission, WC Docket No. 17-108, Restoring Internet Freedom. 2017.
20. "How "Title II" Net Neutrality Undermines 5G," April 2017. Report published by Rysavy Research.
21. "Accelerating Innovation in Unlicensed Spectrum," November 2016. Article published by Fierce Wireless.
22. "IoT &5G: Wait or Move?" October 2016. Report published by Informa.
23. "Mobile Broadband Transformation," August 2016. Report published by 5G Americas.
24. "Threading the Spectrum Needle - Can LTE and Wi-Fi Coexist?" February 2016. Article published by Fierce Wireless.
25. "5G – Promises and Pitfalls," November 2015. Article published by RCR Wireless News.
26. "LTE and 5G Innovation: Igniting Mobile Broadband," August 2015. Report published by 4G Americas.
27. "Latest FCC Auction Shatters Spectrum Myths," January 2015. Article published by Gigaom.
28. "LTE Congestion Management - Enabling Innovation and Improving the Consumer Experience," January 2015. Report published by Mobile Future.
29. "Mobile Broadband Networks Should Not Be Hampered by Net Neutrality Constraints," September 2014. Article published by Fierce Wireless.
30. "How Wireless is Different - Considerations for the Open Internet Rulemaking," September 2014. Report for Mobile Future.
31. "Beyond LTE: Enabling the Mobile Broadband Explosion," August 2014. Report published by 4G Americas.
32. "Will LTE in Unlicensed Spectrum Unlock a Vast Store of Mobile Broadband Capacity?" June 2014. Article published by MIMO World.
33. "How will 5G compare to fiber, cable or DSL?" May 2014. Article published by Fierce Wireless.
34. "It's Time for a Rational Perspective on Wi-Fi," April 2014. Article published by Gigaom.
35. "Complexities of Spectrum Sharing - How to Move Forward," April 2014. Report published by Mobile Future.

36. "Canadian 700 MHz Auction: Analysis of Results." April 2014. Analysis of auction that concluded February 2014 in Canada.

37. "Challenges and Considerations in Defining Spectrum Efficiency," March 2014. Article for Proceedings of the IEEE.

38. "The High and Wide Future of Radio," March 2014. Column for Fierce Wireless.

39. "Uncertain Government Spectrum Policies Have Far-Reaching Consequences," November, 2013. Article for Bloomberg BNA Insights.

40. "Who Owns the Internet of Things?", September 2013. Column for Fierce Wireless co-authored with Chris Rezendes.

41. "Mobile Broadband Explosion - The 3GPP Wireless Evolution," August 2013. Report for 4G Americas.

42. "Learn How Technology Will Turn Less Desirable Airwaves into 'Beachfront' Spectrum," June 2013. Article for Gigaom.

43. "Efficiency of Spectrum Use," May 2013. Article for Fierce Wireless.

44. "2013 Mobile Commerce Survey," May 2013. Report for Information Week.

45. "Trends in Enterprise Cellular Network Data Usage," March 2013. Market research and report done in conjunction with NetMotion Wireless."

46. "White Spaces Networks Are Not "Super" Nor Even Wi-Fi," March 2013. Article for Gigaom.

47. "Mobile Commerce: State of the Market," February 2013. Coauthored report for Information Week.

48. "Vehicles and Mobility Are Converging but Fragmentation, Lack of Standards May Hinder Progress," February 2013. Column for Fierce Wireless.

49. "4G: Carriers, IT Pros Square Off," December 2012. Report for Information Week.

50. "Spectrum – All Options Essential, Including Incentive Auctions," December 2012. Blog for HighTech Forum.

51. "Spectrum Sharing with LTE is Conceivable But Not Trivial," November 2012. Column for Fierce Wireless.

52. "4G World: The Need For More Spectrum," October 2012. Column for Information Week.

53. "Spectrum Sharing Opens a Potential Attack Route," October 2012. Article for Giagaom.

54. "No Silver Bullets for FCC, NTIA Spectrum Challenge," September 2012. Article for Bloomberg BNA.

55. "Mobile Broadband Explosion – The 3GPP Wireless Evolution," September 2012. Report for 4G Americas.

56. "Spectrum Sharing – The Promise and The Reality," July 2012. Report for Mobile Future.

57. “Mobile Network Design and Deployment: How Incumbent Operators Plan for Technology Upgrades and Related Spectrum Needs,” June 2012. Rysavy Research report.
58. “LTE: Huge Technology, Huge Challenges,” March 2012. Report for Information Week.
59. “Wireless Spectrum Doomsday Looms,” January, 2012. Column for InformationWeek.
60. “Unleashing the Wireless Power of Long-Term Evolution: Spectrum, and Lots of It,” December 2011. Article for Bureau of National Affairs (BNA).
61. “Convergence of 3G/4G and Wi-Fi, October 2011. Report for InformationWeek.
62. “Comments on Citi ‘Wireless Supply and Demand’,” October 2011. Analysis and report.
63. “Mobile Broadband Explosion. 3GPP Broadband Evolution to IMT-Advanced (4G),” September 2011. Detailed report for 4G Americas.
64. “Public Safety Spectrum,” July 2011. Analysis and report.
65. “Efficient Use of Spectrum,” May, 2011. Report sponsored by CTIA, filed with the FCC.
66. “The Spectrum Imperative: Mobile Broadband Spectrum and its Impacts for U.S. Consumers and the Economy. An Engineering Analysis,” March 2011. Report sponsored by Mobile Future.
67. “Application Mobilization: A Rapidly Changing Landscape,” January 2011. Report published by Information Week.
68. “Smartphone Efficiency Report,” January 2011. Rysavy Research report.
69. “Innovation Enabled by Mobile Wireless Network Management,” Report sponsored by Mobile Future, filed with the FCC October, 2010.
70. “Strategic Use of Wi-Fi in Mobile Broadband Networks,” October 2010, Rysavy Research white paper.
71. “Transition to 4G – 3GPP Broadband Evolution to IMT-Advanced,” September 2010. Rysavy Research report for 4G Americas.
72. “Spectrum Shortfall Consequences,” April 2010. Analysis written for CTIA and filed with the FCC.
73. “Beyond Smartphones,” February, 2010. Article published by Information Week.
74. “Mobile Broadband Capacity Constraints And the Need for Optimization,” February 2010. Rysavy Research report.
75. “The 2.6 GHz Spectrum Band - Unique Opportunity to Realize Global Mobile Broadband,” December 2009. Report published by GSMA with Peter Rysavy providing the technology analysis on how best to manage the 2.6 GHz band.
76. “Net Neutrality Regulatory Proposals: Operational and Engineering Implications for Wireless Networks and the Consumers They Serve.” Report sponsored by Mobile Future, filed with the FCC January, 2010.

77. “The Mobile Web Imperative,” December 2010. Article published by Information Week.
78. “Air Pressure: Why IT Must Sort Out App Mobilization Challenges,” October, 2009. Analytics report published by Information Week.
79. “Spectrum Crisis?” October, 2009. Article published by Information Week.
80. “HSPA to LTE-Advanced. 3GPP Broadband Evolution to IMT-Advanced (4G)” September 2009. Detailed report published by 3G Americas.
81. “3G Safeguards: Incomplete, Getting Better,” May 2009. Article published by Information Week.
82. “Mobile Broadband Spectrum Demand,” December 2008. Report commissioned by CTIA, released at CTIA Wireless March, 2009.
83. “Femtocells Suit Up For Work,” January 2009. Article published by Information Week.
84. “Wireless E-Mail Efficiency Assessment,” January 2009. Test report.
85. “HSUPA Gets Uploads Almost Up To Download Speeds,” September 2008. Article published by Information Week.
86. “EDGE, HSPA and LTE - Broadband Innovation,” September 2008. White paper, published by 3G Americas.
87. “Code of the Road,” August 2008. Article published by Information Week.
88. “Global Mobile,” May 2008. Article published by Information Week.
89. “GPS Performance,” March 2008. Test report.
90. “Mobile Application Development Quick Start Guide,” March 2008. White paper, published by AT&T.
91. “Harnessing Mobile Middleware”, December 2008. White paper published by AT&T.
92. “Security Requirements for Wireless Networking,” December 2007. White paper.
93. “Mobile Application Development Best Practices,” September 2007. Peter Rysavy co-wrote this white paper, published by AT&T.
94. “EDGE, HSPA, LTE: The Mobile Broadband Advantage”, September 2007, White Paper for 3G Americas
95. “Handheld Computing Evolution”, June 13, 2007, Network Computing Mobile Observer
96. “Reach Me if You Can”, article on wireless application deployment, May 2007, Network Computing Magazine
97. “Global Mobile”, May 23, 2007, Network Computing Mobile Observer
98. “Wireless Networks, Wired Bottlenecks”, May 2, 2007, Network Computing Mobile Observer
99. “Breaking the Gray Flannel Ceiling”, article on mobile IM, April 2007, Network Computing Magazine

100. "QoS and VoIP With 3G: Not an Easy Marriage", Apr 11, 2007, Network Computing Mobile Observer

101. "Mobile Linux Puzzle - Coming Together." March 2007, Network Computing Magazine.

102. "Learning from Bluetooth", Mar 21, 2007, Network Computing Mobile Observer

103. "Disconnect!", Feb 28, 2007, Network Computing Mobile Observer

104. "EV-DO Rev A: Upping the Ante", Feb 7, 2007, Network Computing Mobile Observer

105. "IEEE 802.11n for the Enterprise—Not a Trivial Upgrade", Jan 17, 2007, Network Computing Mobile Observer

106. "Google Embraces Mobile", Dec 20, 2006, Network Computing Mobile Observer

107. "Using VPNs with Wireless Networks", Nov 29, 2006, Network Computing Mobile Observer

108. "Evolved EDGE and the Future of TDMA", Oct 18, 2006, Network Computing Mobile Observer

109. "Wireless E-Mail Efficiency Assessment." Oct 13, 2006. White paper that presents the results of a detailed engineering assessment to compare network efficiency of RIM Blackberry versus Microsoft Direct Push.

110. "Mobile Broadband: EDGE, HSPA & LTE", Sep 2006. White paper published by 3G Americas.

111. "Mobile Computing Policy and De-Perimeterization", Sep 27, 2006, Network Computing Mobile Observer

112. "Trials and Tribulations in Assessing Wireless Network Performance", Sep 6, 2006, Network Computing Mobile Observer

113. "Time to Decide", article on wireless networking, Aug 31, 2006, Network Computing Cover Story

114. "Sprint Nextel, WiMAX and the Mobile Broadband Conundrum", Aug 16, 2006, Network Computing Mobile Observer

115. "Wide-Area Wireless—The Next Five Years", Jul 26, 2006, Network Computing Mobile Observer

116. "Anatomy of a Well-Designed Wireless Application", Jul 5, 2006, Network Computing Mobile Observer

117. "Wireless Network Assessment, EVDO and WiFi Hotspots." A detailed test report on the relative performance of CDMA2000 EVDO and WiFi hotspots. March 21, 2006.

118. "Using Your Cell Phone as a Modem", Jun 14, 2006, Network Computing Mobile Observer

119. “Convergence Update: IMS and UMA”, May 24, 2006, Network Computing Mobile Observer

120. “Mobile Broadband - Trying to Catch a Fast-Moving Target”, May 3, 2006, Network Computing Mobile Observer

121. “Integrated Voice/Data in 3G”, Apr 12, 2006, Network Computing Mobile Observer

122. “Mobile Middleware in the Broadband Era”, Mar 22, 2006, Network Computing Mobile Observer

123. “Figuring Out Metro Wi-Fi”, Mar 1, 2006, Network Computing Mobile Observer

124. “Sprint Nextel's Jump to the Future”, Feb 8, 2006, Network Computing Mobile Observer

125. “The Smartphone Conundrum”, Jan 18, 2006, Network Computing Mobile Observer

126. “Municipal and Mesh Wi-Fi”, Dec 21, 2005, column, Network Computing Mobile Observer

127. “Linksys WRT54G -- Not What It Used to Be”, Nov 30, 2005, column, Network Computing Mobile Observer

128. “Confusion About 4G”, Nov 9, 2005, column, Network Computing Mobile Observer

129. “Strong Capabilities, Difficult Decisions”, Oct 27, 2005, article, Network Computing Magazine

130. “Hard Numbers and Experts' Insights on Migration to Evolved 3G and 4G Wireless Technology”, Oct, 2005, updated public report, published by Datacomm Research

131. “Wireless Data Pricing--One Hundred Times Less Expensive and Still Not Satisfied”, Oct 19, 2005, column, Network Computing Mobile Observer

132. “Secure Mobile Access Using SSL VPNs”, Oct 2005, white paper, published by Aventail

133. “Embedded Wireless WAN”, Sep 28, 2005, column, Network Computing Mobile Observer

134. “Redefining the Endpoint--Wireless Broadband Routers”, Sep 7, 2005, column, Network Computing Mobile Observer

135. “Data Capabilities: GPRS to HSDPA and Beyond”, Sep 2005, white paper, published by 3G Americas

136. “High Speed Downlink Packet Access (HSDPA)”, Aug 17, 2005, column, Network Computing Mobile Observer

137. “The Uneven Uptake of Wireless Data”, Jul 21, 2005, column, Network Computing Mobile Observer

138. "Where is WiMAX?", Jul 6, 2005, column, Network Computing Mobile Observer

139. "Mobile Broadband and the Multi-Network Path to 4G", Jul 2005, article, WiMAX Business and Technology Strategies

140. "Freed Up or Tied Down", Jul 21, 2005, article, Network Computing Magazine

141. "Wireless E-Mail for the Masses, Jun 15, 2005, column, Network Computing Mobile Observer

142. "Parallel Mobile Universes", May 25, 2005, column, Network Computing Mobile Observer

143. "Beyond the Airlink- IP Multimedia Subsystem", May 4, 2005, column, Network Computing Mobile Observer

144. "Secure Wireless Networking Using SSL VPNs", May 2005, white paper, published by Aventail

145. "3 Sides to 3G", Apr 13, 2005, column, Network Computing Mobile Observer

146. "Hard Numbers and Experts' Insights on Migration to Evolved 3G and 4G Wireless Technology", Feb, 2005, public report, published by Datacomm Research

147. "Forever Evolving", Oct 14, 2004, article, Network Computing Magazine

148. "Data Capabilities: GPRS to HSDPA", Sep 2004, white paper, published by 3G Americas

149. "Brush up on Bluetooth", Jun 24, 2004, article, Network Computing Magazine

150. "Policing the Airwaves", May 7, 2004, article, Secure Enterprise Magazine

151. "Device Drivers (Smartphones and Wireless PDAs)", Apr 15, 2004, article, Network Computing Magazine

152. "Making the Smart Choice (Smartphone and Wireless PDA Platform Review), Apr 15, 2004, article, Network Computing Magazine

153. "Wireless Instant Messaging: Propelling SMS and Desktop IM to the Next Level", Oct 27, 2003, public report, published by Datacomm Research

154. Common Goals, Unique Strengths – Survey of Hotspot Operators, May 15, 2003, article, Network Computing Magazine

155. "Data Capabilities for GSM Evolution to UMTS", Nov 19, 2002, white paper, published by 3G Americas.

156. "Wireless Nirvana", Oct 21, 2002, article, Network Computing Magazine

157. "Voice Capacity Enhancements for GSM Evolution to UMTS", Jul 18, 2002, white paper, published by 3G Americas.

158. "Networking Standards and Wireless Networks", 2002, white paper, published by NetMotion Wireless

159. "Public Wireless LANs: Challenges, Opportunities and Strategies", Jul 9, 2001, public report, published by Datacomm Research

160. "Break Free With Wireless LANs", Oct 29, 2001, article, Network Computing Magazine

161. "MMDS Struggles to Find a Foothold", Oct 29, 2001, article, Network Computing Magazine

162. "Can MWIF Unify Cellular Protocols?", May 2001, column, M-Business Magazine

163. "M-Wallets: Not Ready Yet", Apr 2001, column, M-Business Magazine

164. "AT&T's GSM Move Could Ignite U.S. Market", Mar 2001, column, M-Business Magazine, March 2001

165. "Lessons From I-Mode", Feb 2001, column, M-Business Magazine

166. "E-Commerce Unleashed", Jan 22, 2001, article, Network Computing Magazine

167. "Mobile-Commerce ASPs Do the Legwork", Jan 22, 2001, article, Network Computing Magazine.

168. "Big Step to Mobile Payments", Jan 2001, column, M-Business Magazine.

169. "Emerging Technology: Clear Signals for General Packet Radio Service", Dec 2000, article, Network Magazine.

170. "WAP: Untangling the Wireless Standard", Nov 2000, article, Network Computing Magazine

171. "The Road to a Wireless Future", Oct 30, 2000, article, Network Computing Magazine

172. "Wireless Wonders (HiperLAN and Bluetooth) Coming Your Way", May 2000, article, Network Magazine.

173. "Managing Mobile Code", Aug 23, 1999, online manual, Network Computing Magazine.

174. "The Evolution of Cellular Data: On the Road to 3G", 1999, article published by Intel "On The Road To PCS", February 15, 1996, article, Network Computing Magazine.

175. "Wireless IP - A Case Study", Apr 30, 1999, article, PCS Data Today online journal

176. "Broadband Wireless: Now Playing in Select Locations", Oct 7, 1999, article, Data Communications Magazine

177. "Satellite Services: Don't Join the Space Race", Sep 21, 1999, column, Data Communications Magazine

178. "Making the Case for Fixed Wireless Technology", Jul 1999, column, Data Communications Magazine

179. “Wireless IP: Ready to Lift Off?”, Mar 1999, column, Data Communications Magazine.

180. “Planning and Implementing Wireless LANS”, 1999, online manual, Network Computing Magazine.

181. “Wireless Broadband and Other Fixed-Wireless Systems”, 1998, online manual, Network Computing Magazine.

182. “General Packet Radio Service (GPRS)”, September 30, 1998, GSM Data Today online journal.

183. “Wide-Area Wireless Computing”, 1997, online manual, Network Computing Magazine.

184. “Internet-To-Go, Now With Mobile IP”, November 1, 1997, article, Network Computing Magazine.

185. “Making The Call With Two-Way Paging”, January 15, 1997, article, Network Computing Magazine.

186. “Cellular Data Communications Made Easy”, July 1, 1997, article, Network Computing Magazine.

187. “Wireless Data Made To Order”, March 15, 1996, article, Network Computing Magazine.

188. “TCP/IP: The Best Protocol for Remote Computing”, public white paper, WRQ. 1996.

189. “Message Middleware In A Wireless Environment”, April 15, 1996, article, Network Computing Magazine.

190. “On The Road To PCS”, Feb 15, 1996, article, Network Computing Magazine

191. “The ABCs of PCS,” Nov 7, 1994, article, Network World.

7. Wireless Courses

The following lists the public courses that Rysavy Research has taught. These are listed in the order of most recent to oldest. Rysavy Research has also privately taught on wireless technology at AT&T, Bluetooth SIG, Cingular Wireless, Cricket Communications, Intel, Medtronic, Microsoft, NetMotion Wireless, RIM, Tektronix, Teledyne, T-Mobile, and the U.S. Department of Defense.

1. Interop Conference, Las Vegas, May 2013. "Wireless Everywhere: LTE and Beyond," 1 hour course.
2. Bellevue, WA, April 2013. "4G: Deep Technology Insights," 1 day course.
3. Interop Conference, Las Vegas, May 2012. "LTE Update," 1 hour course.
4. Bellevue, WA, April 2012. “Mobile Broadband Explosion,” 1 day course.
5. Redmond, WA, December 2010. "Mobile Broadband - Technology Evolution and Strategic Considerations," 1 day course.

6. Portland, OR, November 2010. "Mobile Broadband - Technology Evolution and Strategic Considerations," 1 day course.
7. AT&T Developer Program, March 2010, "Guidelines for Delivering Streaming Services on AT&T's Wireless Network," 1 hour webcast.
8. Bellevue, WA, Oct 2009. "Mobile Broadband - Entering the 4G Decade," 1.5 hour session at IEEE Wireless Workshop.
9. Bellevue, WA, Apr 2009. Portland, OR, May 2009. "Mobile Broadband Innovation - 3G to 4G Evolution and Impacts," 1 day course.
10. 3G Americas, Dec 2008, "EDGE, HSPA, LTE - Broadband Innovation," 1 hour webcast.
11. AT&T Developer Program, August 2008, "Broadband Innovation - Applications for New Broadband Networks," 1 hour webcast.
12. AT&T Developer Program, June 2008, "Emerging Mobile Application Architectures," 1 hour webcast.
13. AT&T Developer Program, March 2008, "Understanding Mobile Application Development Environments: Open Platforms, Tools, Capabilities, Developer Strategies," 1 hour webcast.
14. AT&T Developer Program, Dec 2007, "Harnessing Mobile Middleware - Architectures, Functions and Integration," 1 hour webcast.
15. AT&T Developer Program, Sep 2007, "Best Practices for Mobile Application Development - Strategies, Considerations, and Techniques for Optimal Development," 1 hour webcast.
16. AT&T Developer Program, Apr 2007, "How Enterprises Can Get Ready for IP Multimedia Subsystem (IMS): IMS Strategies and Application Development Approaches," 1 hour webcast.
17. Bellevue, WA, May 2006, "Evolution of Mobile Broadband", 1 day course.
18. Portland State University, Apr 2006, "Wireless Technology Advances: Wi-Fi, 3G, WiMAX, Mobile Broadband", 1 day course.
19. Portland State University, Sep 2005, "3G, Evolved 3G, 4G and WiMAX", 1 day course.
20. Bellevue, WA, April 2005, "Wireless Technology Advances", 1 day course.
21. CTIA Wireless Data University, Mar 2005, "Wi-Fi and WiMAX in Detail", half day course.
22. Portland State University, Jan 2005, "Wi-Fi Technology - Evolution and Integration", 1 day course.
23. CTIA Wireless Data University, Oct 2004, Wi-Fi - Technology, Evolution, Adoption and Hotspots, Added Section: WiMAX", half day course.
24. Portland State University, Jun 2004, "3G, WiMAX and other Wide-Area Broadband Wireless Networks", 1 day course.

25. CTIA Wireless Data University, Mar 2004, "Wi-Fi - Technology, Evolution, Adoption and Hotspots", half day course.
26. Portland State University, Nov 2003, "Wi-Fi - Evolution, Adoption and Hotspots", 1 day course.
27. CTIA Wireless Data University, Oct 2003, "Wi-Fi Technology - Evolution, Adoption and Hotspots", half day course.
28. IEEE Wireless LAN Conference, 2002, "Wireless LAN Business and Marketing Issues", 1 hour.
29. Portland State University, 2002, "WLANs, 3G Cellular and Beyond", 2 day course.
30. Portland State University, 2001, "Next Generation Cellular Data", 1 day course.
31. CMP Web 2001, "The Wireless Web in Detail", 1 day course.
32. IEEE Chapter Evening Presentation, 2001, "Wireless Networking Advances - Setting Reasonable Expectations", 2 hours.
33. UCLA, 2001, "Wireless Data Systems", 1 day course.
34. CMP Web 2000, "Wireless Data Networks", 1 day course.
35. UCLA, 2000, "Wireless Data Systems", 2 day course.
36. UCLA, 1999, "New Third Generation Cellular, Digital PCS and Broadband Mobile Data - What Will Dominate?", 4 day course co-taught with C. R. Baugh Ph.D.
37. Portable Design Conference, 1999, "Wireless Data Integration", 1 day course.
38. Northcon, 1998, "Wireless Data Networking Advances", 1 day course.
39. UCLA, 1998, "Technologies for Wireless Competitive Markets: Cellular, PCS and Wireless Data", 4 day course co-taught with C. R. Baugh Ph.D.
40. UCLA, 1997, "Cellular, PCS and Wireless Data Technology", 4 day course co-taught with C. R. Baugh Ph.D.
41. UCLA, 1996, "Wireless Voice And Data Communications (Personal Communications Services, Digital Cellular, and Wireless Data)", 4 day course co-taught with C. R. Baugh Ph.D.
42. UCLA, 1995, "Wireless Voice And Data Communications (Personal Communications Services, Digital Cellular, and Wireless Data)", 4 day course co-taught with C. R. Baugh Ph.D.
43. UCLA, 1994, "Wireless Voice And Data Communications (Personal Communications Services, Digital Cellular, and Wireless Data)", 4 day course co-taught with C. R. Baugh Ph.D.

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